



SAUDI PORTS AUTHORITY
JEDDAH ISLAMIC PORT

CALCULATION REPORT of SHORING SYSTEM

DOCUMENT NO: KASK-2023-U-SA-01-DE-REP-001-R04

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03	15.05.2023	Reinforcement calculations revised.	Atalay Mert TURGUT	Senol ADATEPE	Serkan YOLACAN
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1. Introduction

The objective of this design report is to represent analysis of shoring wall with all in the content of Development of the Port Platform (From 26 To 31) Project Jeddah Islamic Seaport (JIP), Jeddah – KSA. Project locations is given Figure 1.



Figure 1 – Project Location

2. Geotechnical Investigations

There are two soil reports. These are;

- 1- **CGS18009-** Geotechnical Soil Investigation for Development of the Port Platform (From 26 To 31) Project Jeddah Islamic Seaport (JIP), Jeddah - KSA Prepared by **Bakri**, dated **June 2018**.
- 2- **ACTS-KSA-Q20017-22-Final** Geotechnical Investigation Report for Development of the Port Platform (From 26 To 31) Project Jeddah Islamic Seaport (JIP), Jeddah - KSA Prepared by **ACTS**, dated **April 2022**.

The general layout plan and idealized soil profile for the geotechnical investigation report dated 2018 are given in the following tables, respectively.

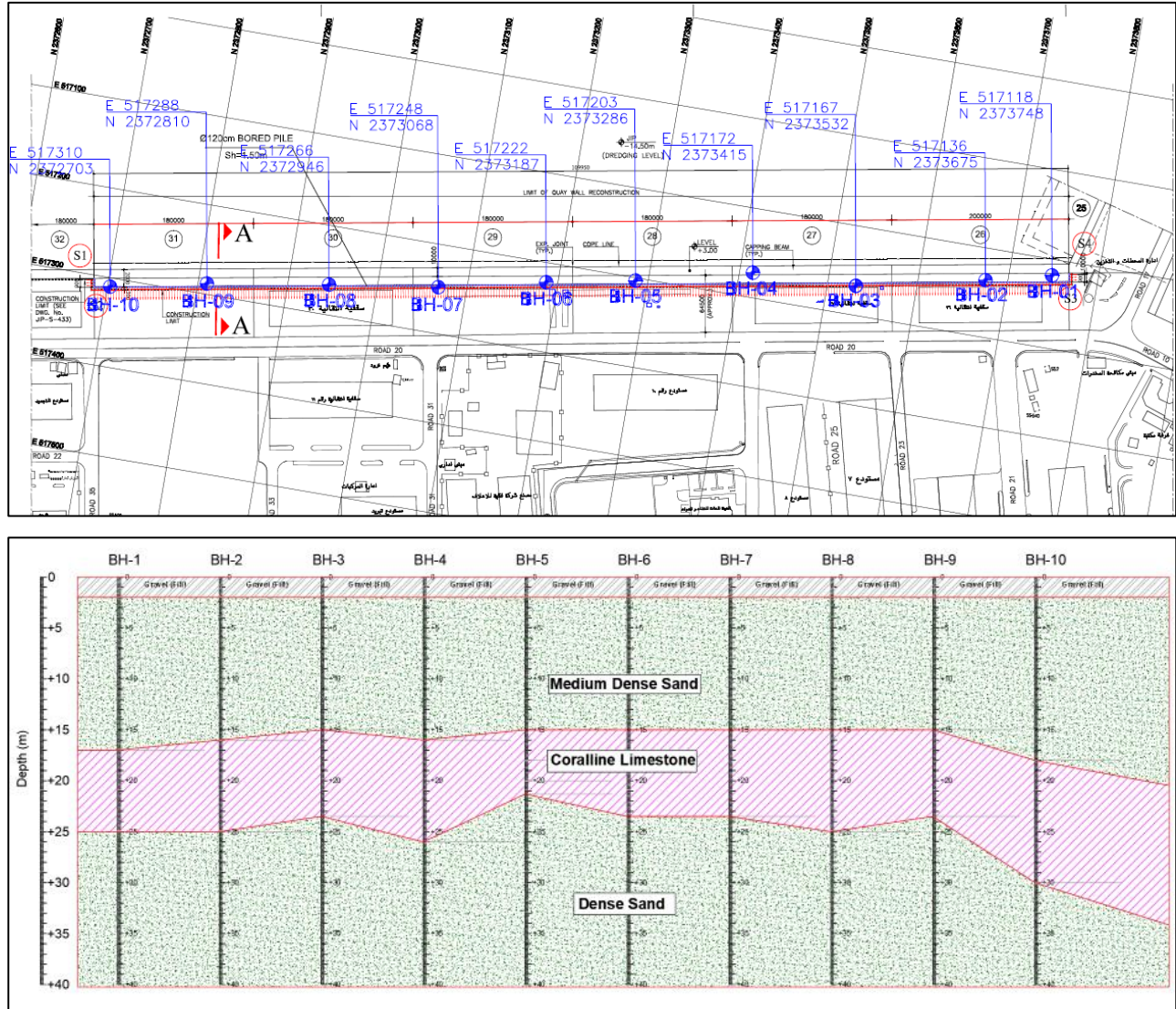


Figure 2. Borehole Layout Plan and Idealized Soil Profile - Bakri (2018)

Variation of SPT-N Values with Depth is given in the table below.

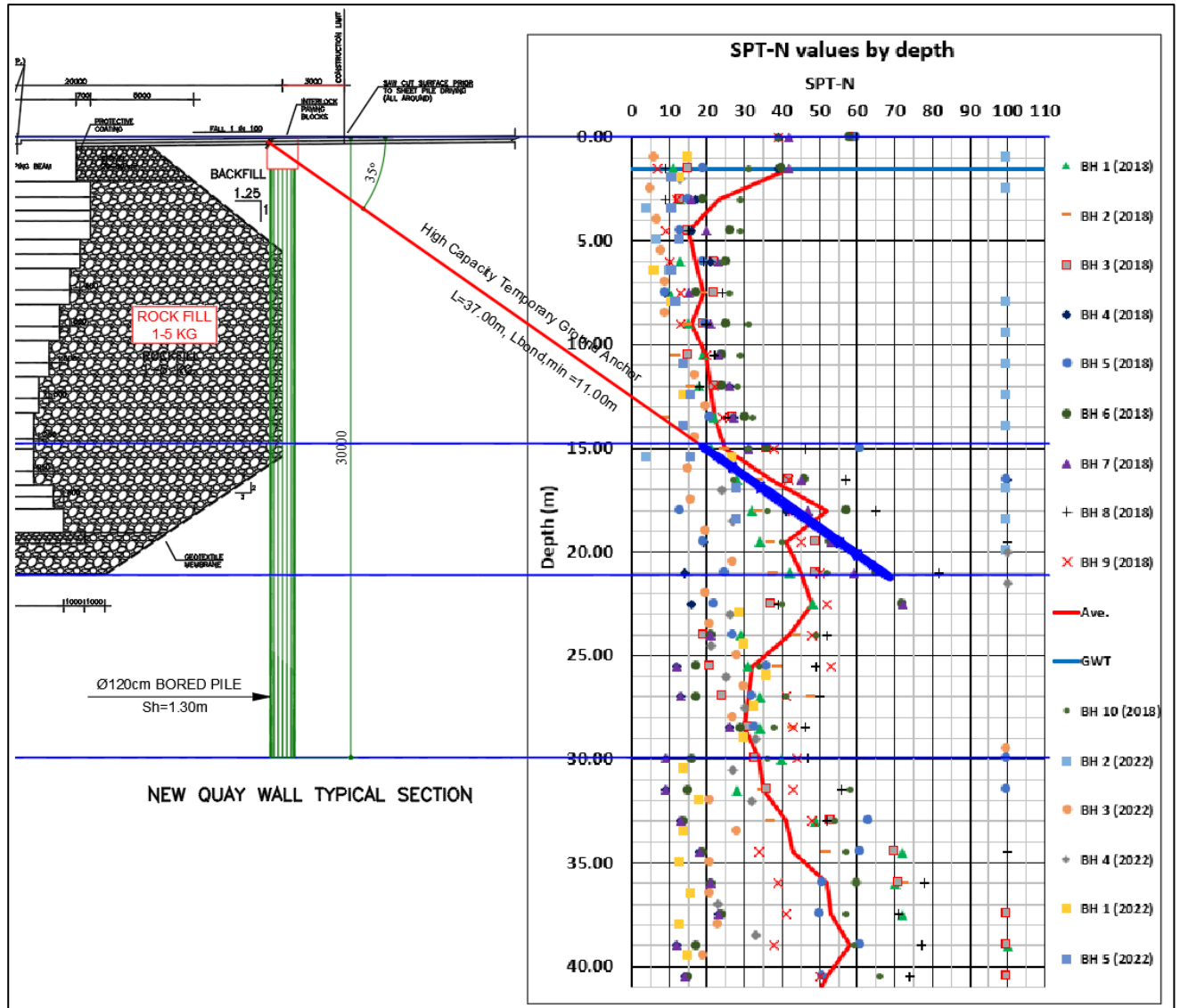


Figure 3. Variation of SPT-N Values with Depth- Bakri (2018)

The general layout plan and idealized soil profile for the geotechnical investigation report dated 2022 are given in the following tables, respectively.

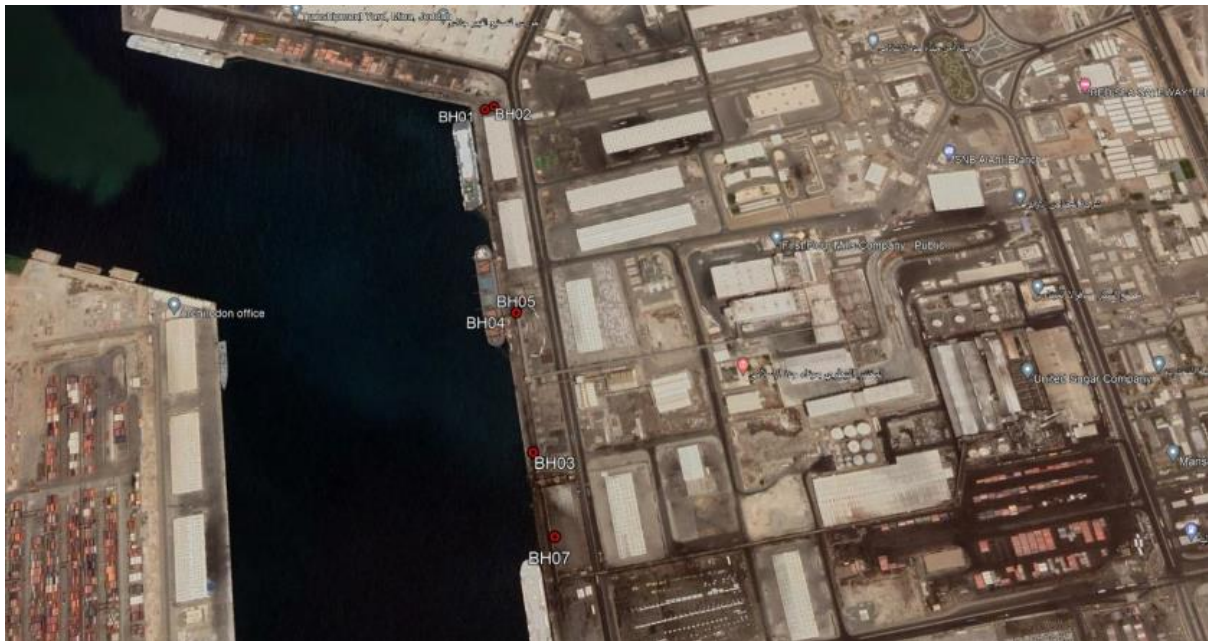


Figure 4. Borehole Layout Plan - ACTS (2022)

The soil profiles estimated from the boreholes in the geotechnical investigation report dated 2022 are given in the figures below.

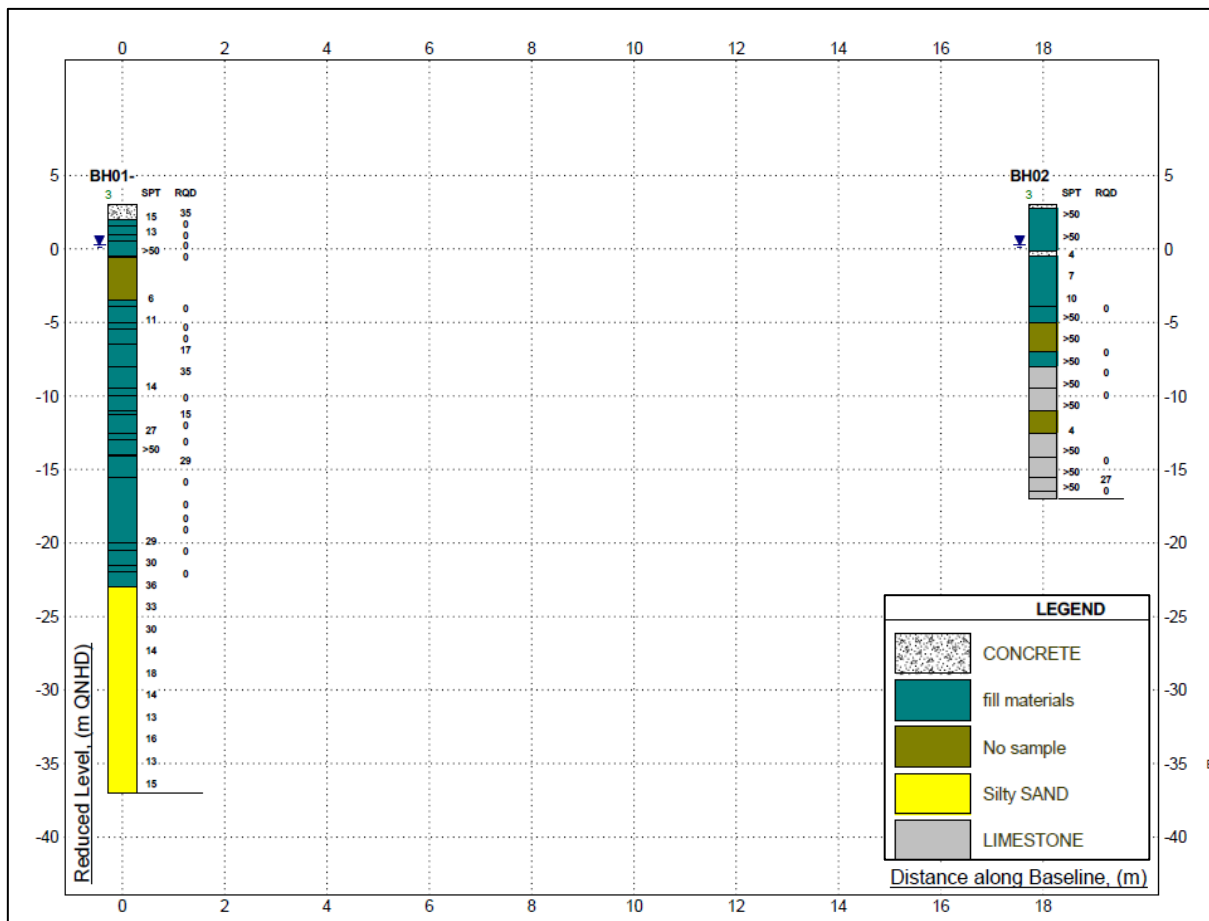


Figure 5. Soil Profile of BH-01 and BH-02 - ACTS (2022)

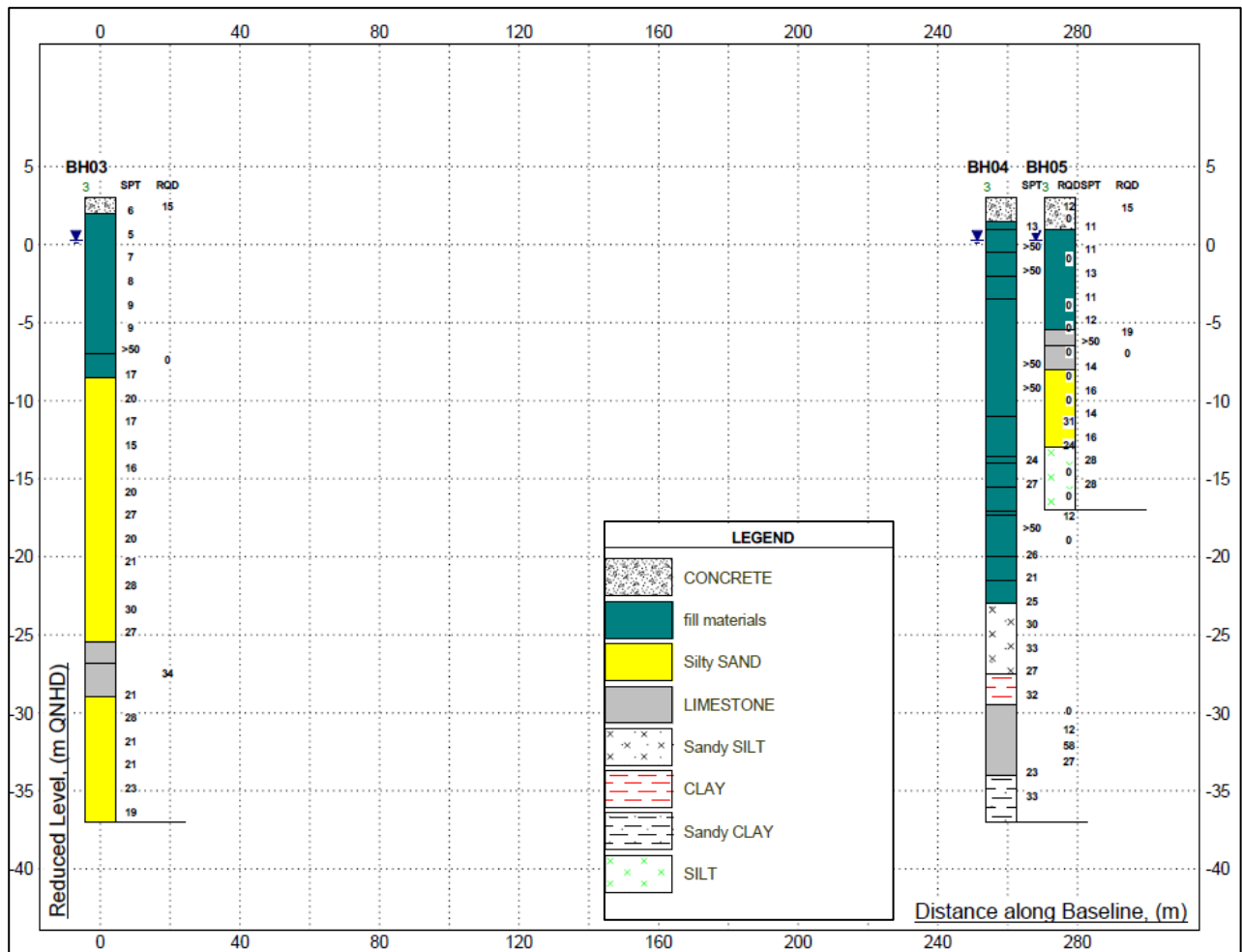


Figure 6. Soil Profile of BH-03, BH-04 and BH-05 - ACTS (2022)

The following tables contain photos of the core boxes:

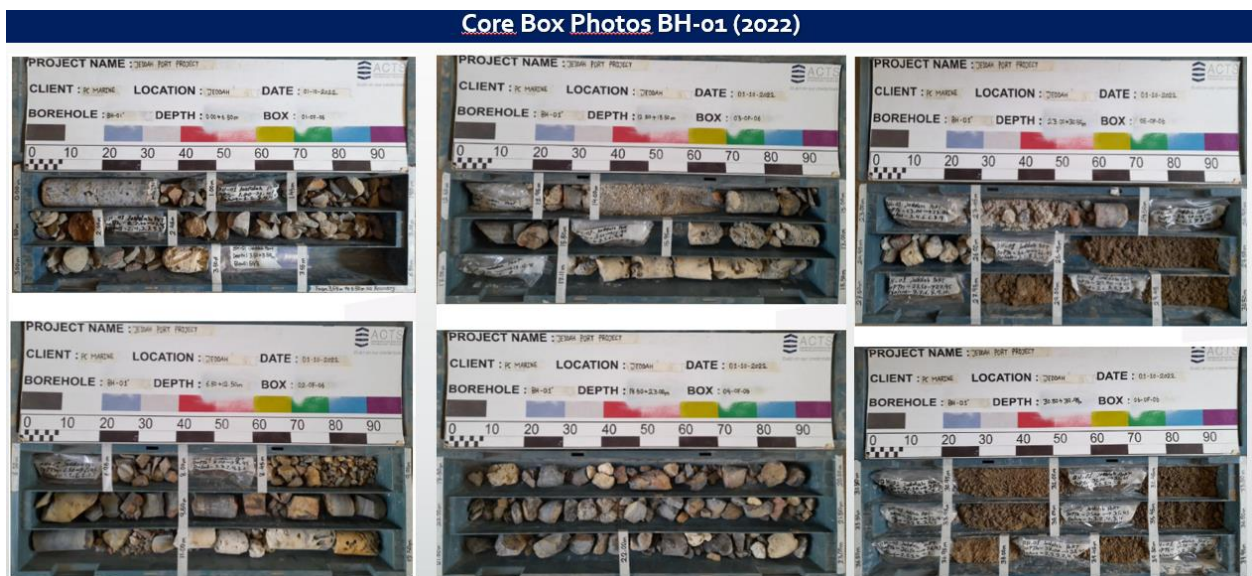


Figure 7. Core-box Photos- ACTS (2022)

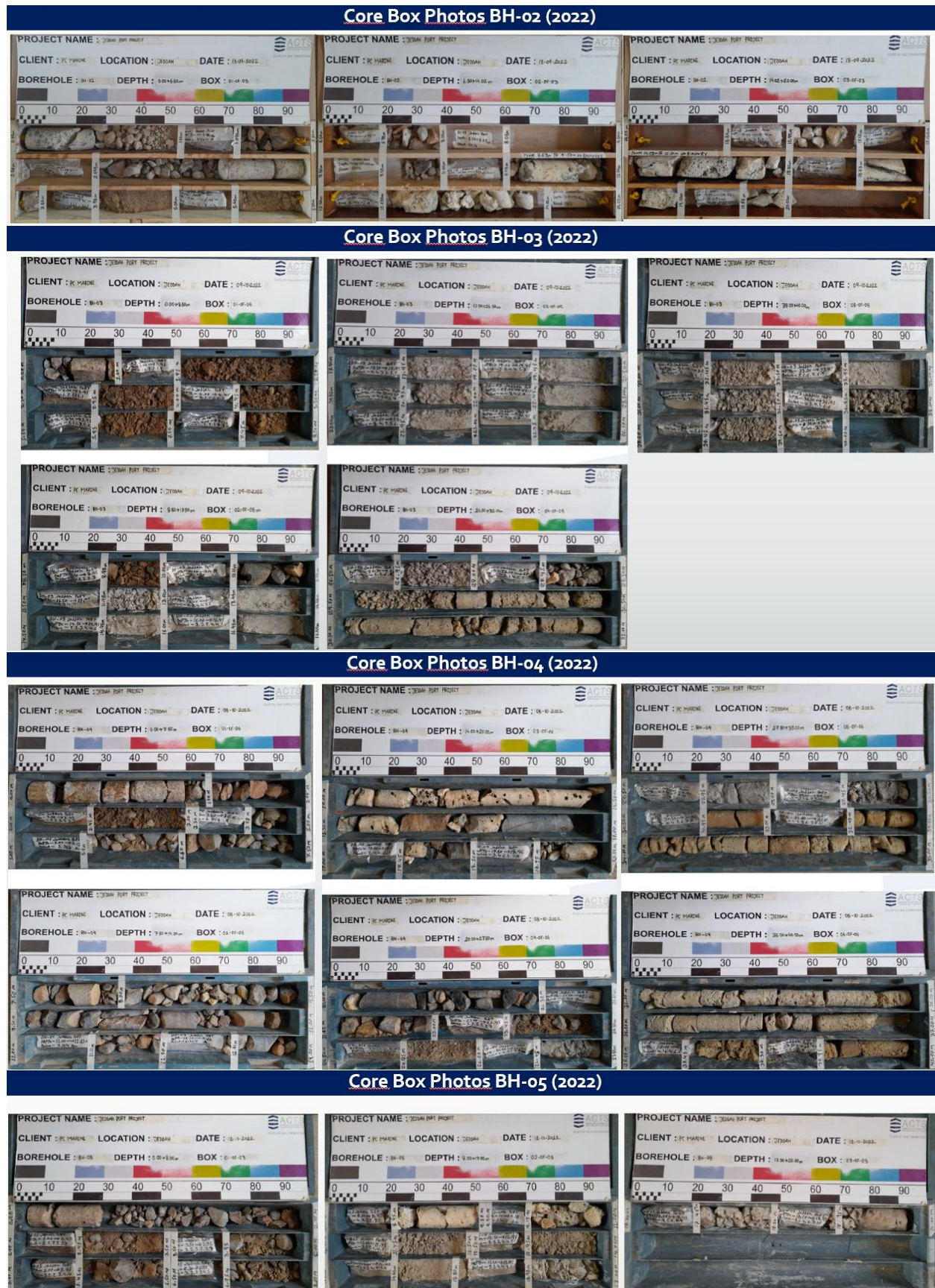


Figure 7. Core-box Photos- ACTS (2022) -Cont.

The references for the shoring analysis within the scope of this report are "CGS18009: Geotechnical Soil Investigation for Development of the Port Platform (From 26 to 31) Project Jeddah Islamic Seaport (JIP), Jeddah - KSA Prepared by Bakri, dated June 2018" and "ACTS-KSA-Q20017-22: Final Geotechnical Investigation Report for Development of the Port Platform (From 26 to 31) Project Jeddah Islamic Sea. The groundwater level is observed at a depth of 3 meters below ground level, according to the indicated geotechnical report. Geotechnical design parameters for each unit are given in Table 1.

Table 1. Design Parameters

Formation	Material Model	Selected Design Parameters		
		c'	ϕ'	E50
		(kPa)	(°)	(MPa)
Loose Sand	HS	1	32	10
Coraline Limestone	HS	10	36	75
Medium Dense Sand	HS	2	35	35
Rock Fill	HS	1	37	100

3. Geotechnical Calculations

The soil and material parameters using in calculations are given below tables. 20 kPa and 40 kPa surcharge load is considered during construction period. Shoring system calculation was carried out by using PLAXIS Software. PLAXIS is used finite element method. The finite element procedure uses a mesh to model the soil body basically like a truss, in which stresses and strains are calculated considering the above-mentioned relationship in conjunction with the equilibrium of forces and the compatibility of displacements at nodes. The boundary conditions such as restraints for vertical and horizontal displacements at the edges of the mesh or loads applied to nodes to define the surcharge, the location of the ground water table and structural elements such as beams and anchors are defined on the mesh as an input geometry. Outputs of the procedure are evaluated for the checking of any design by means of stress, displacement and stability. Geotechnical calculations were made using PLAXIS software. All excavation stages were taken into account in the calculations. The values presented as a result of the calculation are the envelope values that take into account all stages.

The soil and material parameters using in calculations are given below tables.

Table 2 - Materials - Soil and interfaces - Hardening soil

Identification number		1	2	3	4
Identification		Loose Sand	Medium Dense Sand	Coraline Limestone	Rock Fill
Soil model		Hardening Soil	Hardening Soil	Hardening Soil	Hardening Soil
Drainage type		Drained	Drained	Drained	Drained
Colour					
Comments					
γ_{unsat}	kN/m ³	19.00	19.00	20.00	22.00
γ_{sat}	kN/m ³	20.00	20.00	21.00	23.00
e_init		0.5000	0.5000	0.5000	0.5000
n_init		0.3333	0.3333	0.3333	0.3333
E ₅₀ ^{ref}	kN/m ²	10.00E3	35.0E3	75.0E3	100.0E3
E _{oed} ^{ref}	kN/m ²	12.00E3	35.0E3	75.0E3	100.0E3
E _{ur} ^{ref}	kN/m ²	30.0E3	105.0E3	225.0E3	300.0E3
v_ur		0.2000	0.2000	0.2000	0.2000
K ₀ ^{nc}		0.4701	0.4264	0.4122	0.3982
C _{ref}	kN/m ²	1.000	1.00	10.00	1.00
φ (phi)	°	32.00	35.00	36.00	37.00
ψ (psi)	°	0.000	0.000	6.000	7.000
Set to default values		Yes	Yes	Yes	Yes
R _f		0.9000	0.9000	0.9000	0.9000
Determination		v-undrained definition	v-undrained definition	v-undrained definition	v-undrained definition
v _u definition method		Direct	Direct	Direct	Direct
v _u ,equivalent (nu)		0.4950	0.4950	0.4950	0.4950
Skempton B		0.9866	0.9866	0.9866	0.9866
K _{w,ref/n}	kN/m ²	1.844E6	4.302E6	9.219E6	9.219E6
Soil class (Standard)		Coarse	Coarse	Coarse	Coarse
< 2 μm	%	10.00	10.00	10.00	10.00
2 μm - 50 μm	%	13.00	13.00	13.00	13.00
50 μm - 2 mm	%	77.00	77.00	77.00	77.00
K ₀ determination		Automatic	Automatic	Automatic	Automatic
K _{0,x}		0.4701	0.4264	0.4122	0.3982
K _{0,z}		0.4701	0.4264	0.4122	0.3982
OCR		1.000	1.000	1.000	

Table 3 - Materials – Plates

Identification		D=120 cm Bored Pile Sh=1.40 m	D=120 cm Bored Pile Sh=1.50 m (Back Pile)
Identification number		2	2
Comments			
Colour			
Material type		Elastic	Elastic
Isotropic		Yes	Yes
EA ₁	kN/m	24.23E6	22.62E6
EA ₂	kN/m	24.23E6	22.62E6
EI	kN m ² /m	2.181E6	2.036E6
d	m	1.039	1.039
w	kN/m/m	5.000	5.000
v (nu)		0.1500	0.1500
Rayleigh α		0.000	0.000
Rayleigh β		0.000	0.000
Prevent punching		Yes	Yes
Identification number		1	1

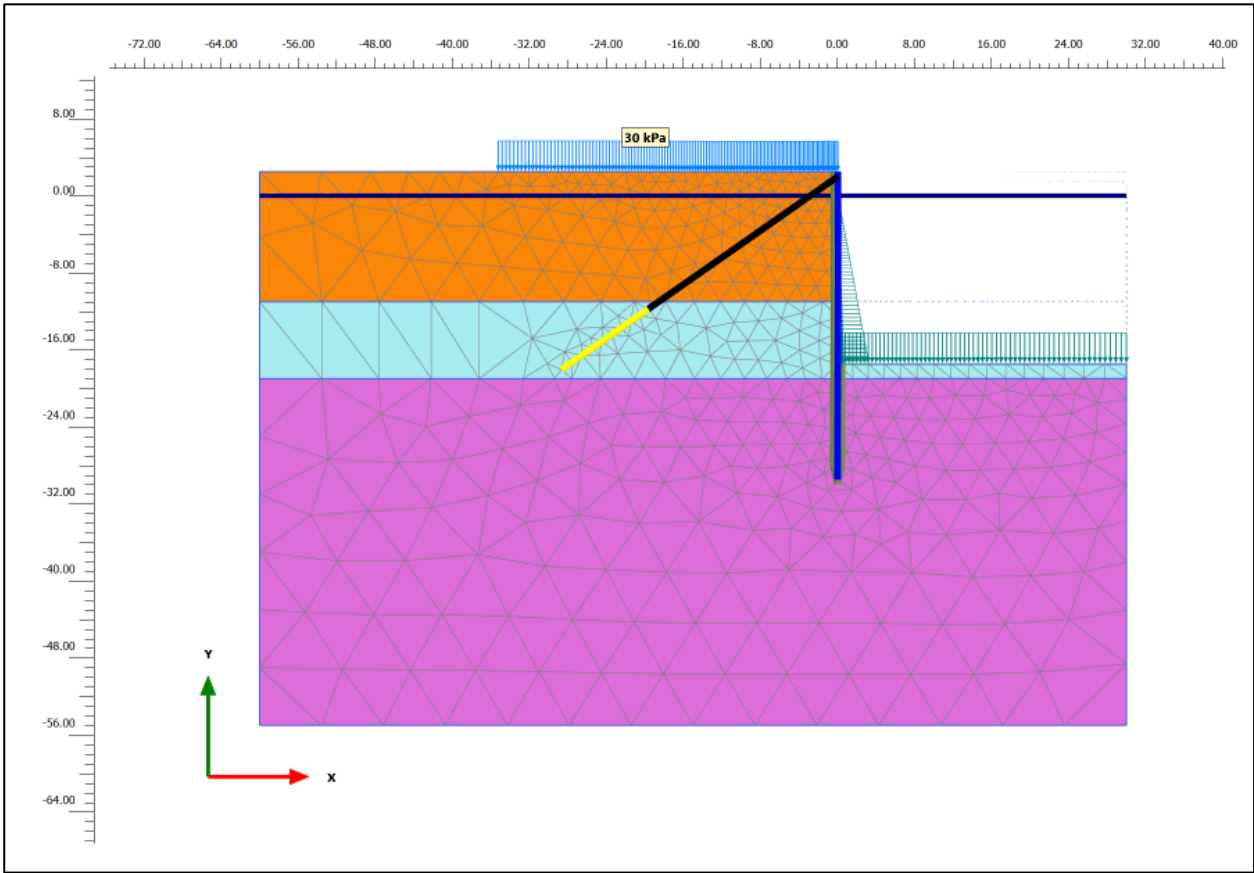
Table 4 - Materials – Anchors

Identification		10x0.6-inch Super Tendon Sh=2.8 m	D=63.5mm Tie-Rod Sh=3.0 m
Identification number		1	1
Comments			
Colour			
Material type		Elastoplastic	Elastoplastic
EA	kN	273.0E3	665.07E3
L _{spacing}	m	2.800	3.000
F _{max,tens}	kN	1600	1758
F _{max,comp}	kN	1.00	1.00

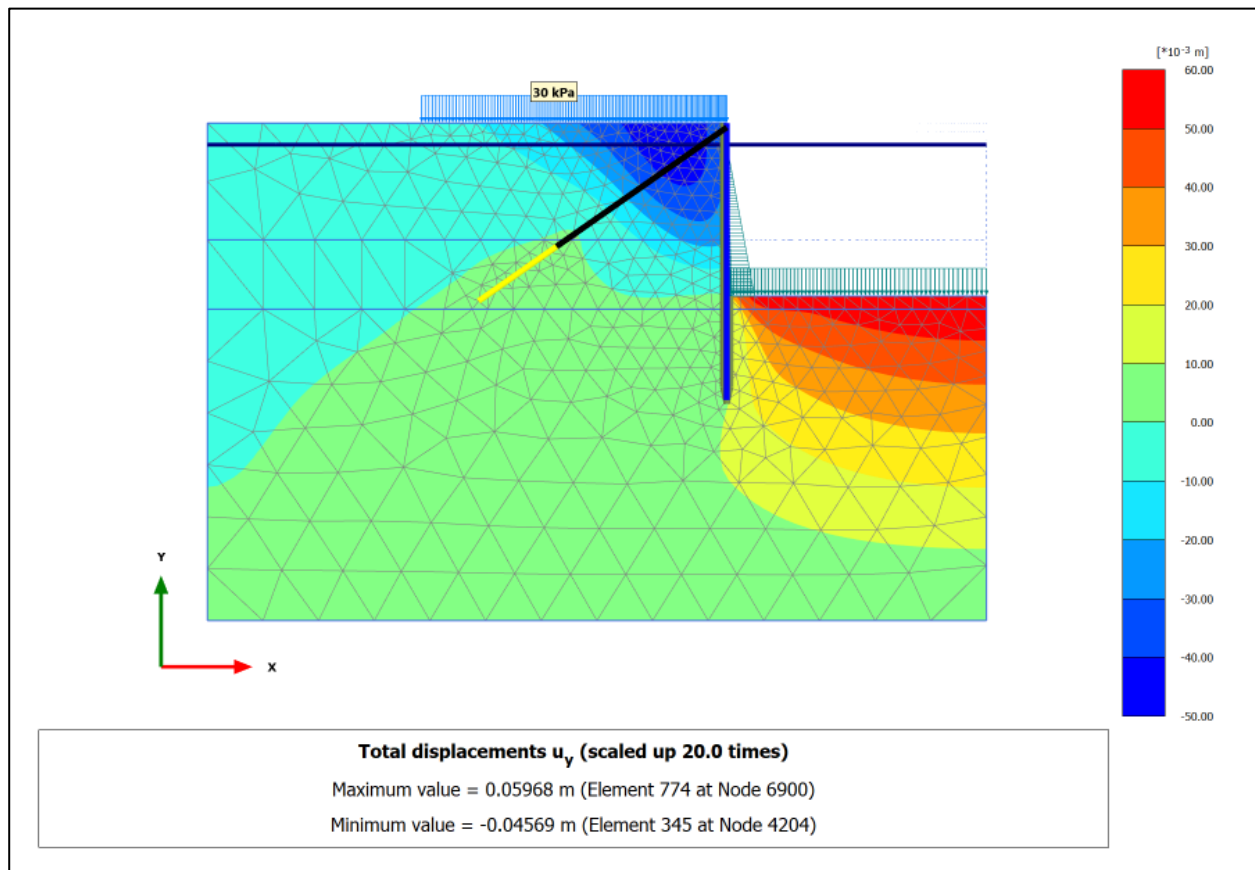
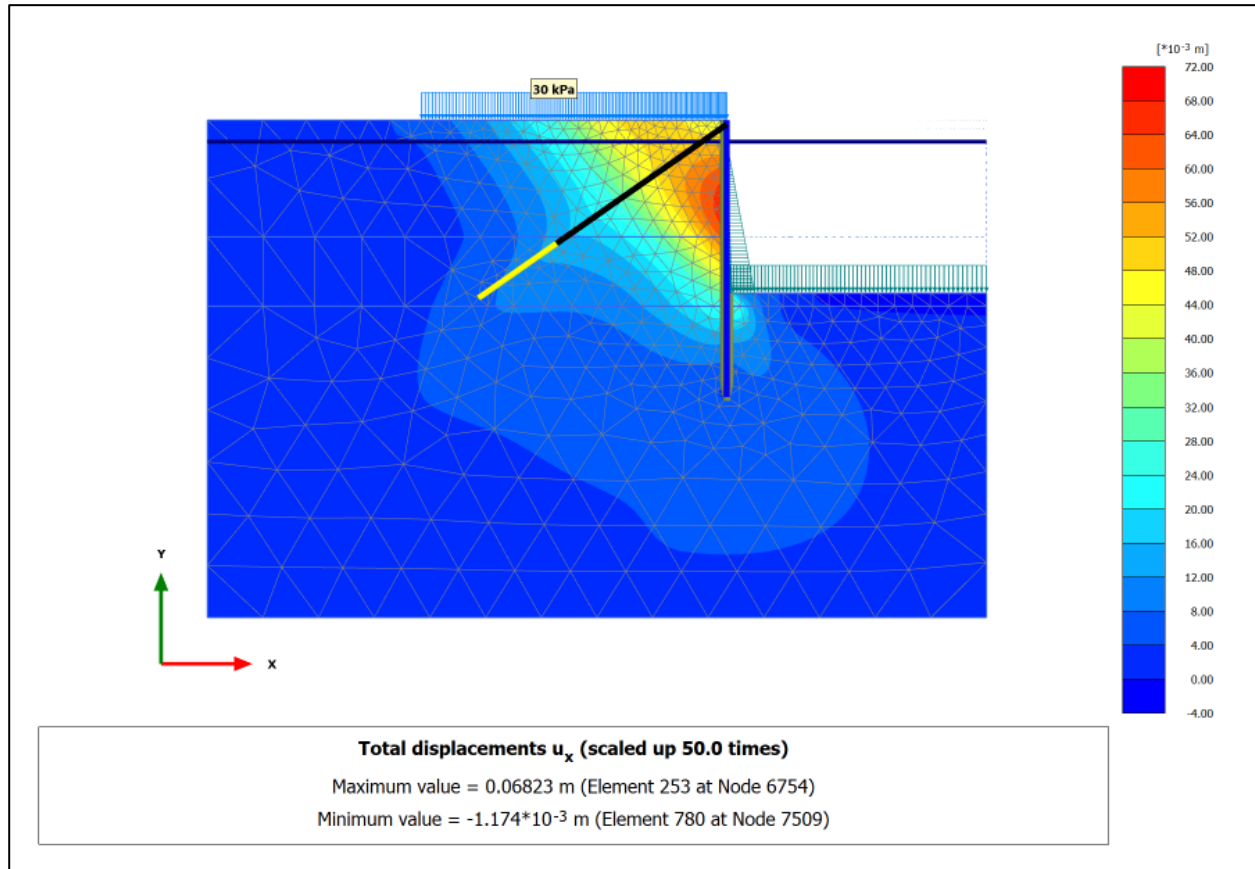
Table 5 - Materials – Geogrids

Identification		Bonded Length
Identification number		1
Comments		
Colour		
Material type		Elastic
Isotropic		Yes
EA ₁	kN/m	175.0E3
EA ₂	kN/m	175.0E3
Identification number		1
Identification number		1

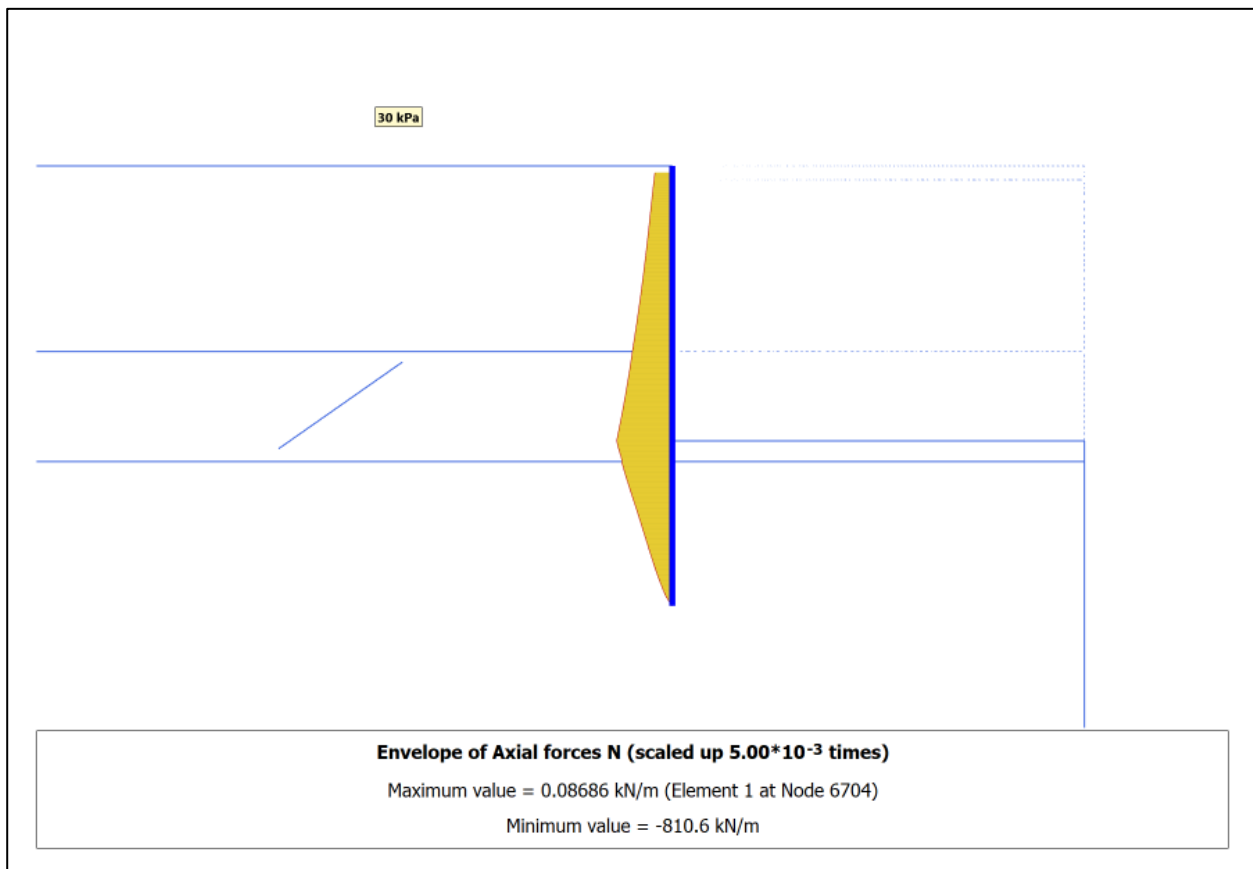
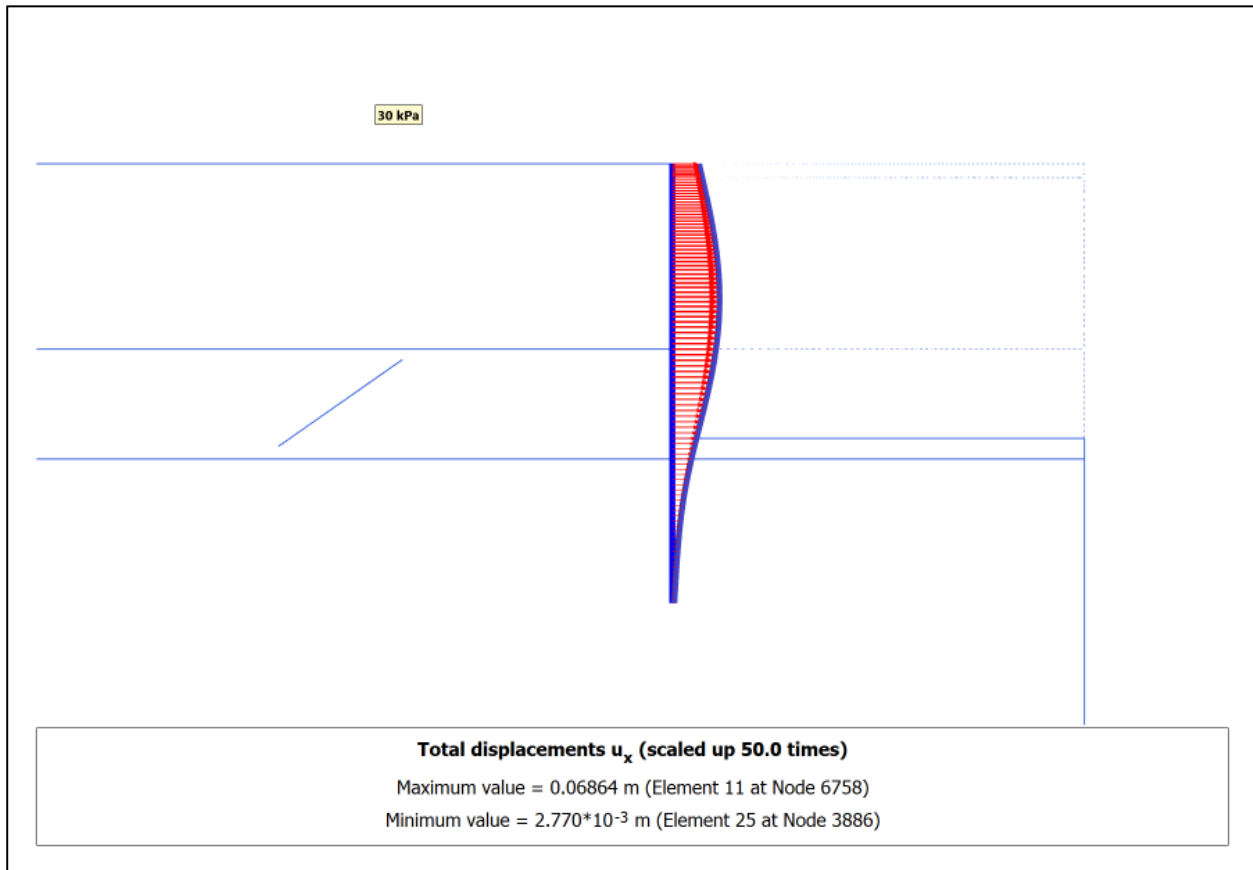
3.1 Section A

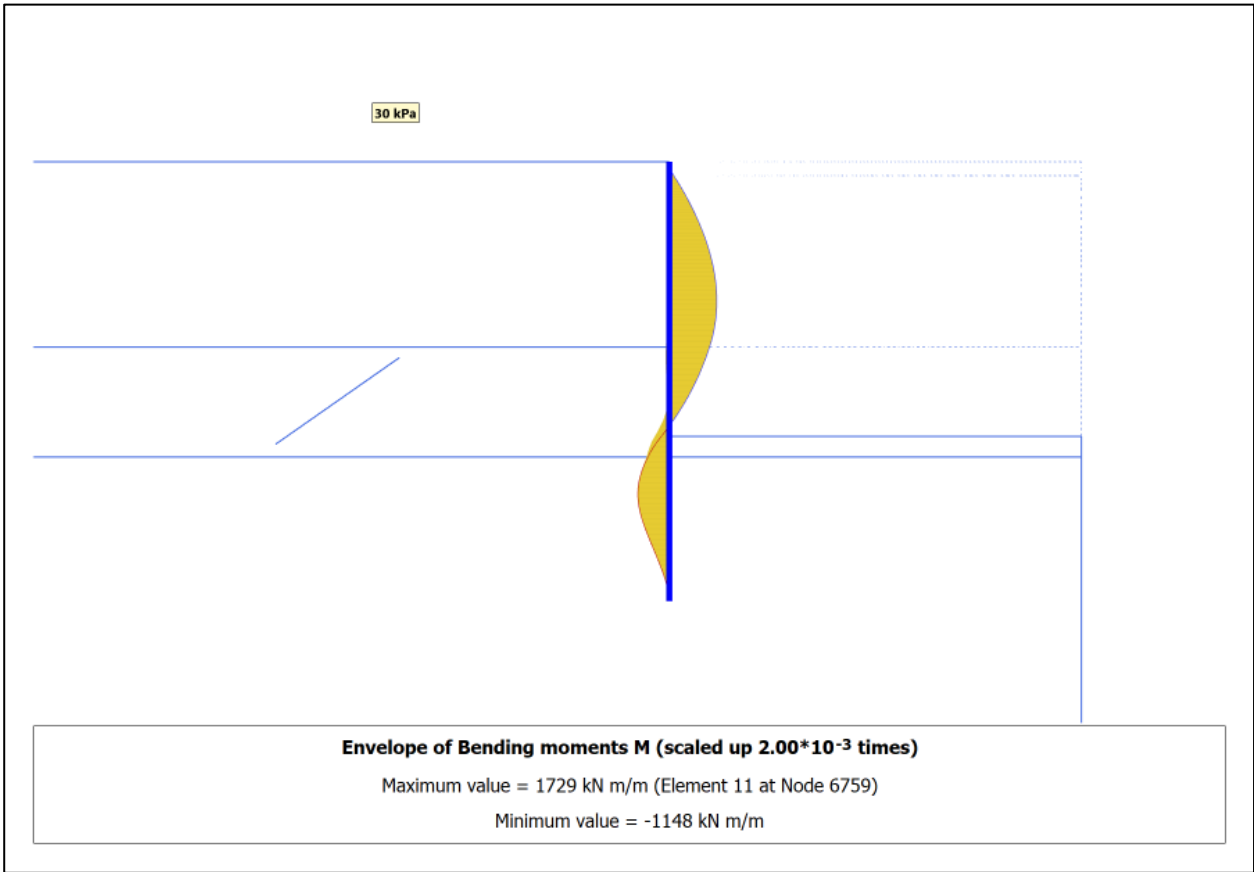
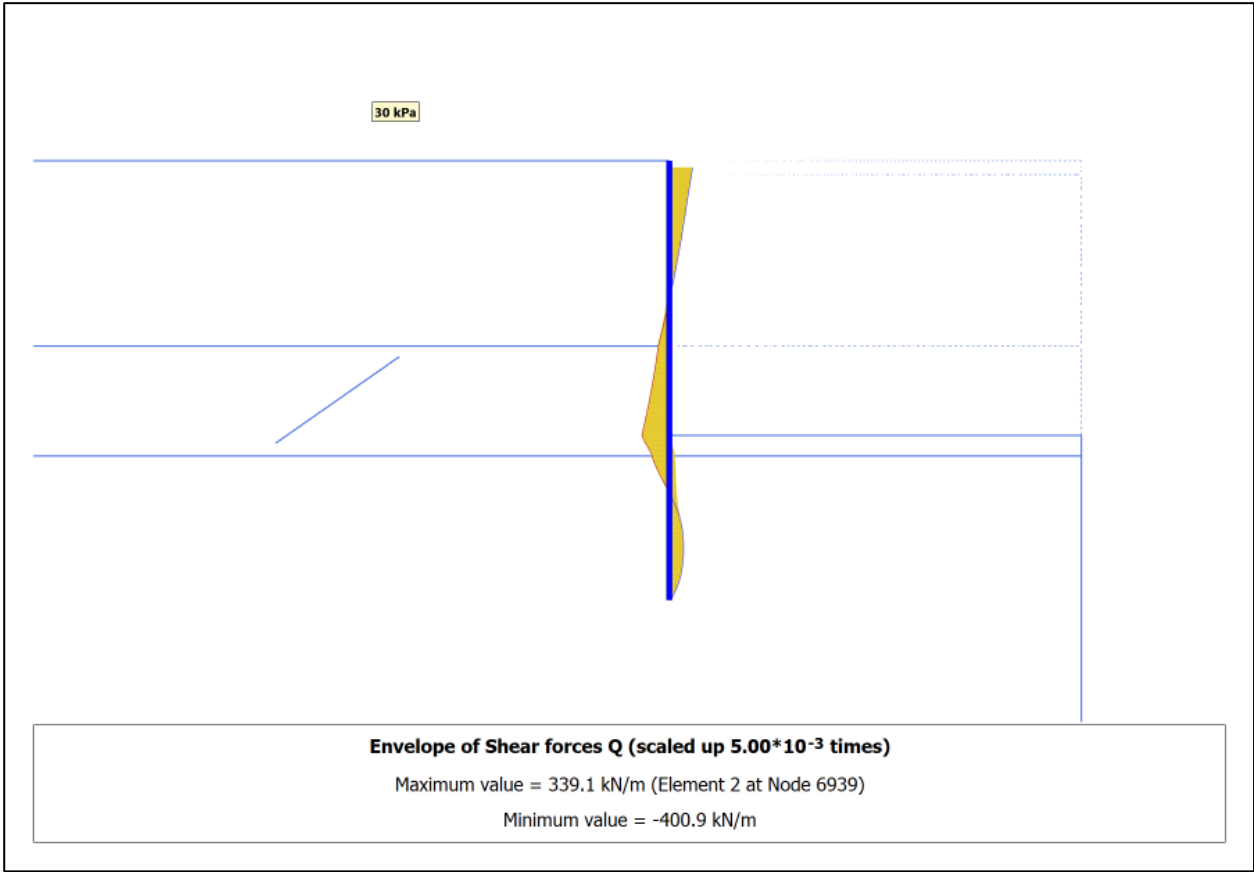


-  Coraline Limestone
-  Loose Sand
-  Medium Dense Sand



3.1.1 Internal Forces of Bored Pile

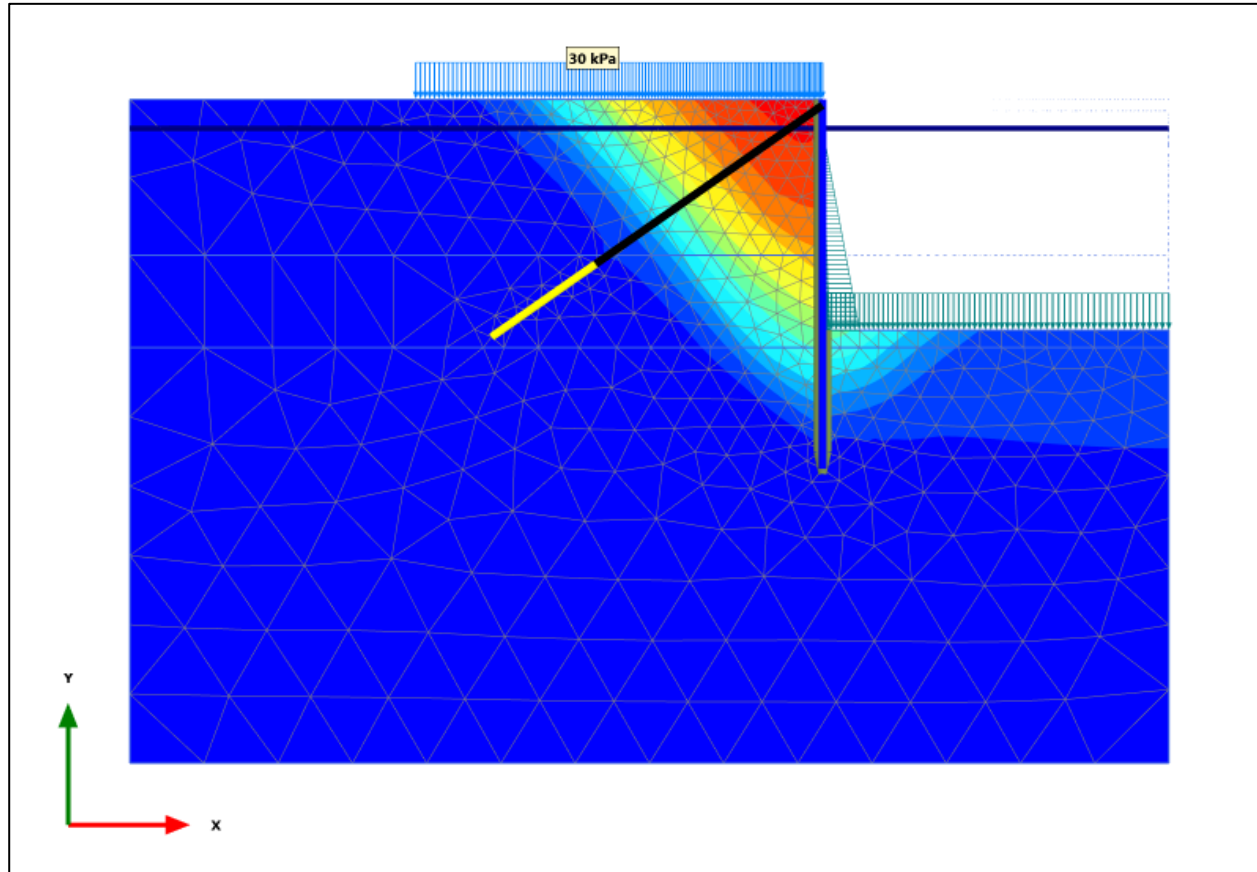




Anchor Forces

Structural element	Node	Local number	X [m]	Y [m]	N [kN]	N _{min} [kN]	N _{max} [kN]
NodeToNodeAnchor_1_1	6939	1	0.000	2.000	1200.000	0.000	1200.000
Element 1-1 (Node-to-node anchor)	2755	2	-19.660	-11.766	1200.000	0.000	1200.000

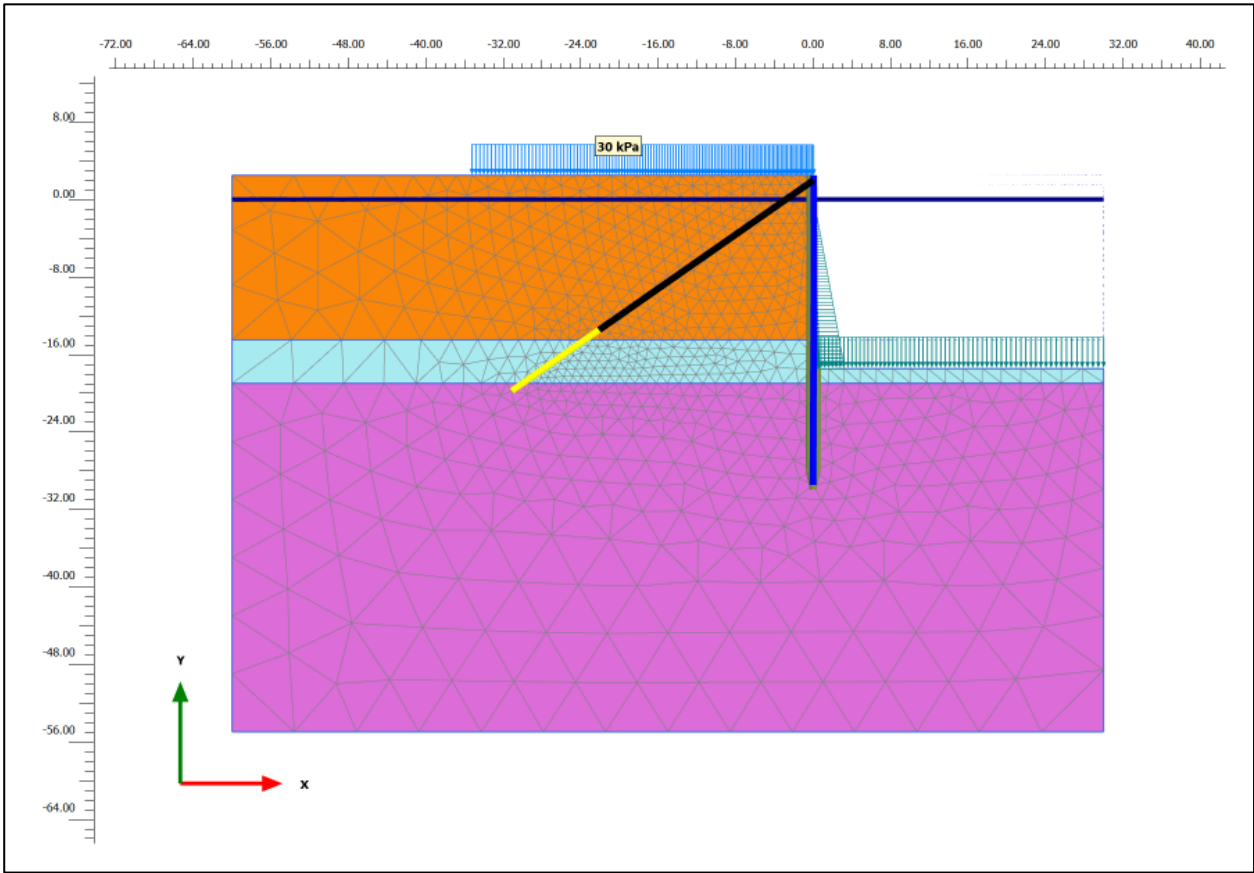
3.1.2 Overall Stability Analysis



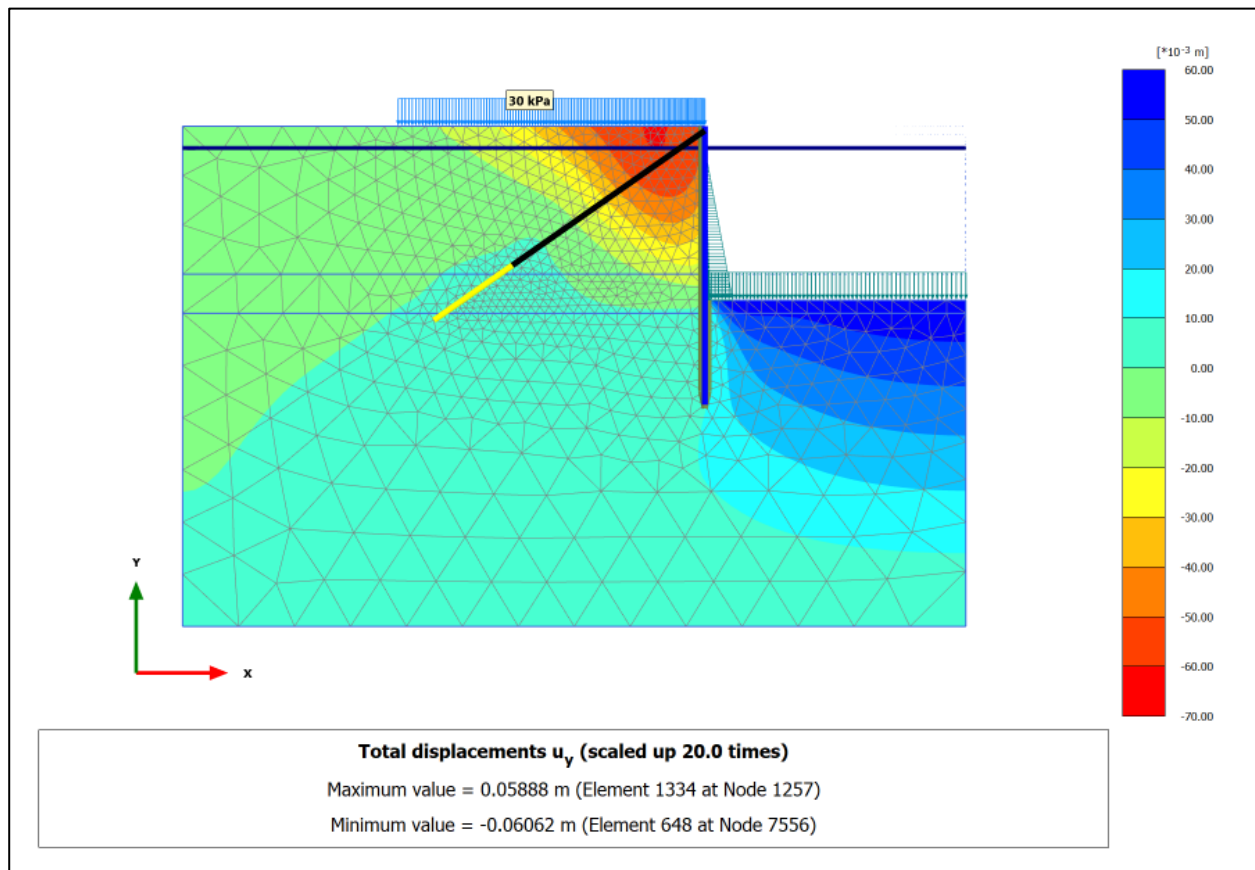
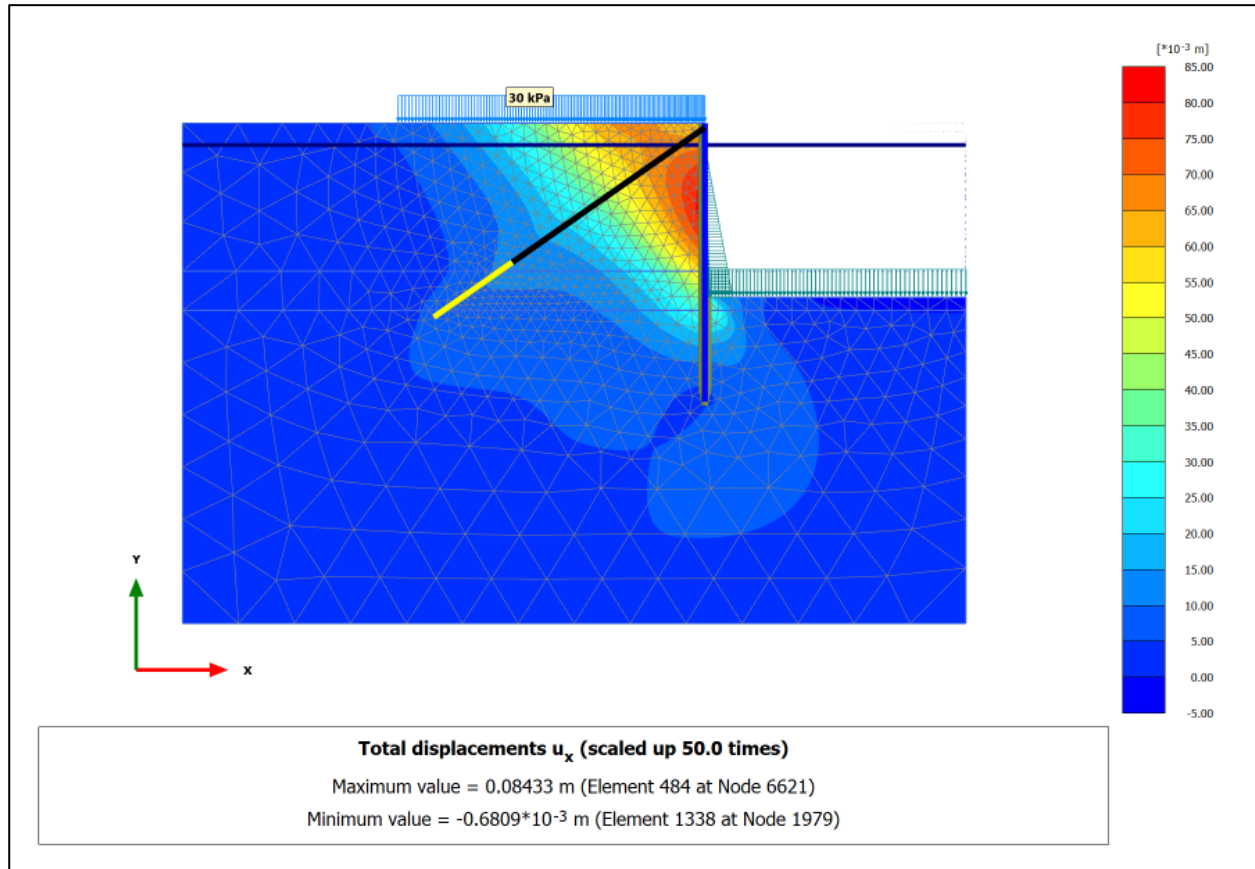
Multipliers				
Soil weight			ΣM_{Weight}	1.000
Strength reduction factor	M_{sf}	0.8730E-3	ΣM_{sf}	1.575
Time	Increment	0.000	End time	0.000

Overall Factor of Safety: $1.575 > 1.35$ OK

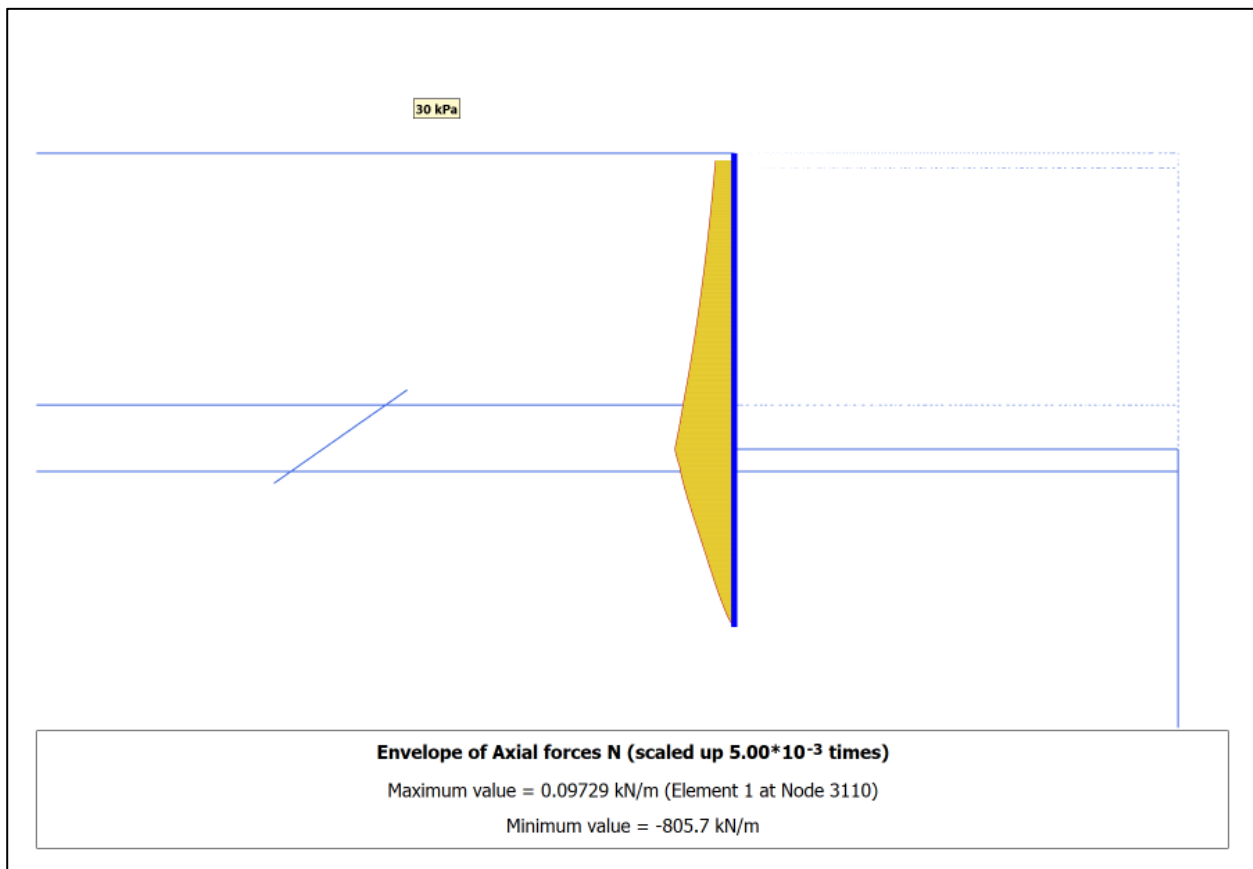
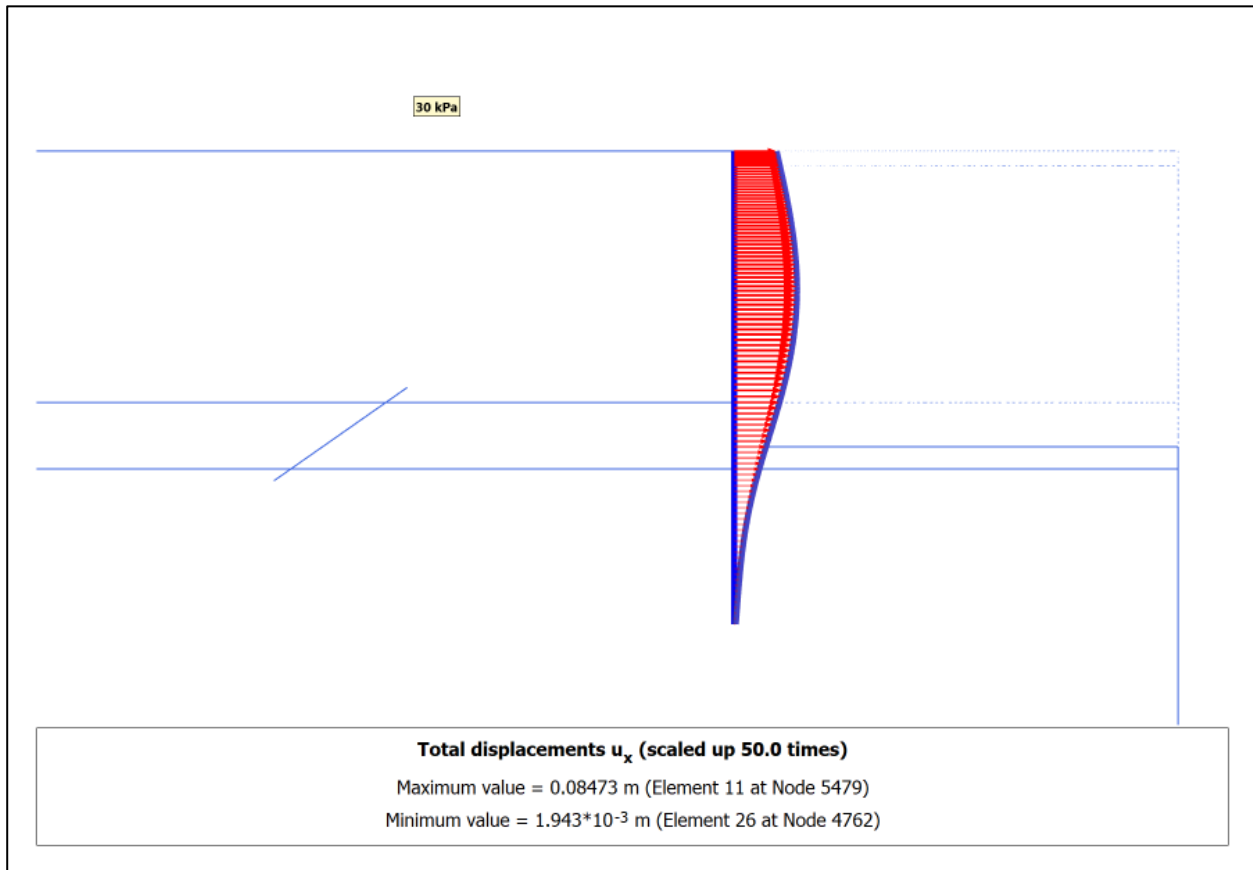
3.2 Section B

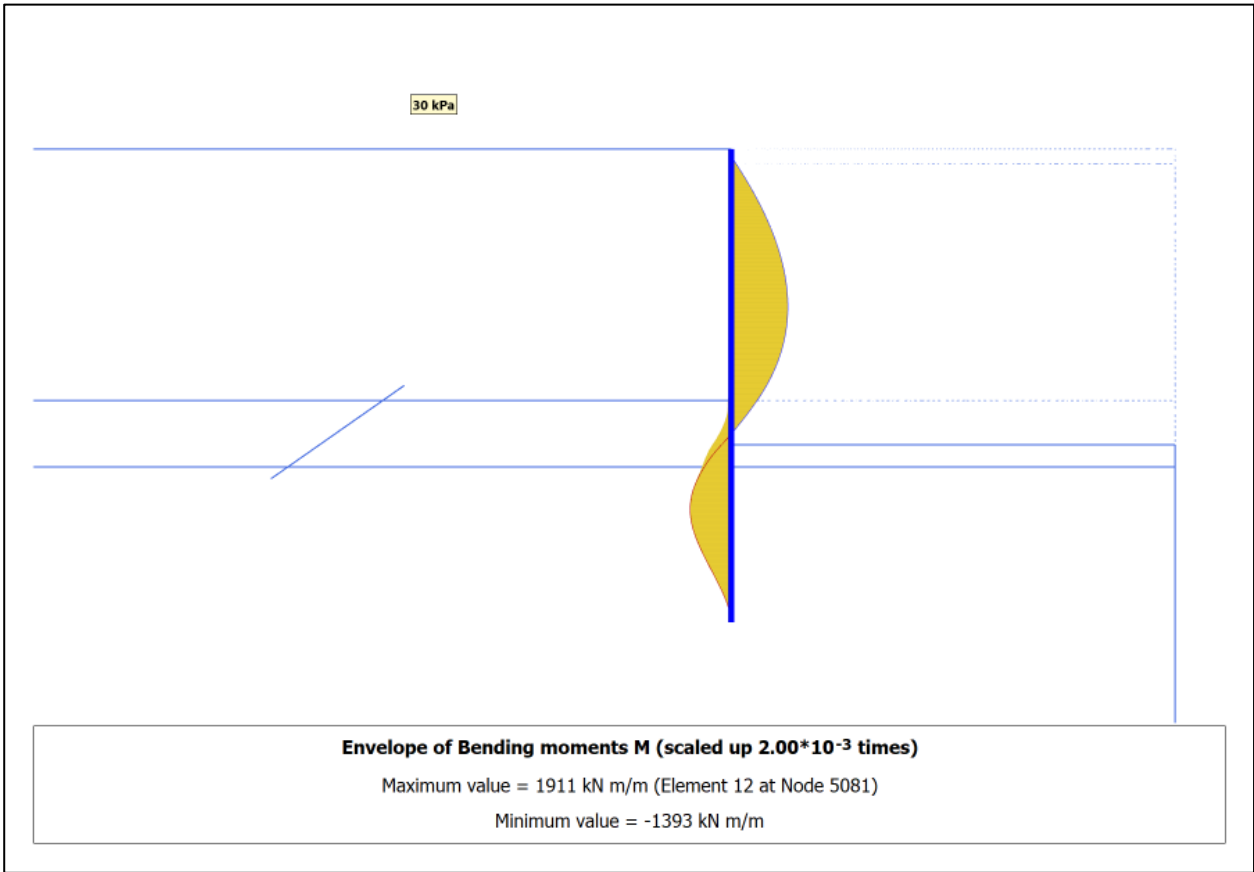
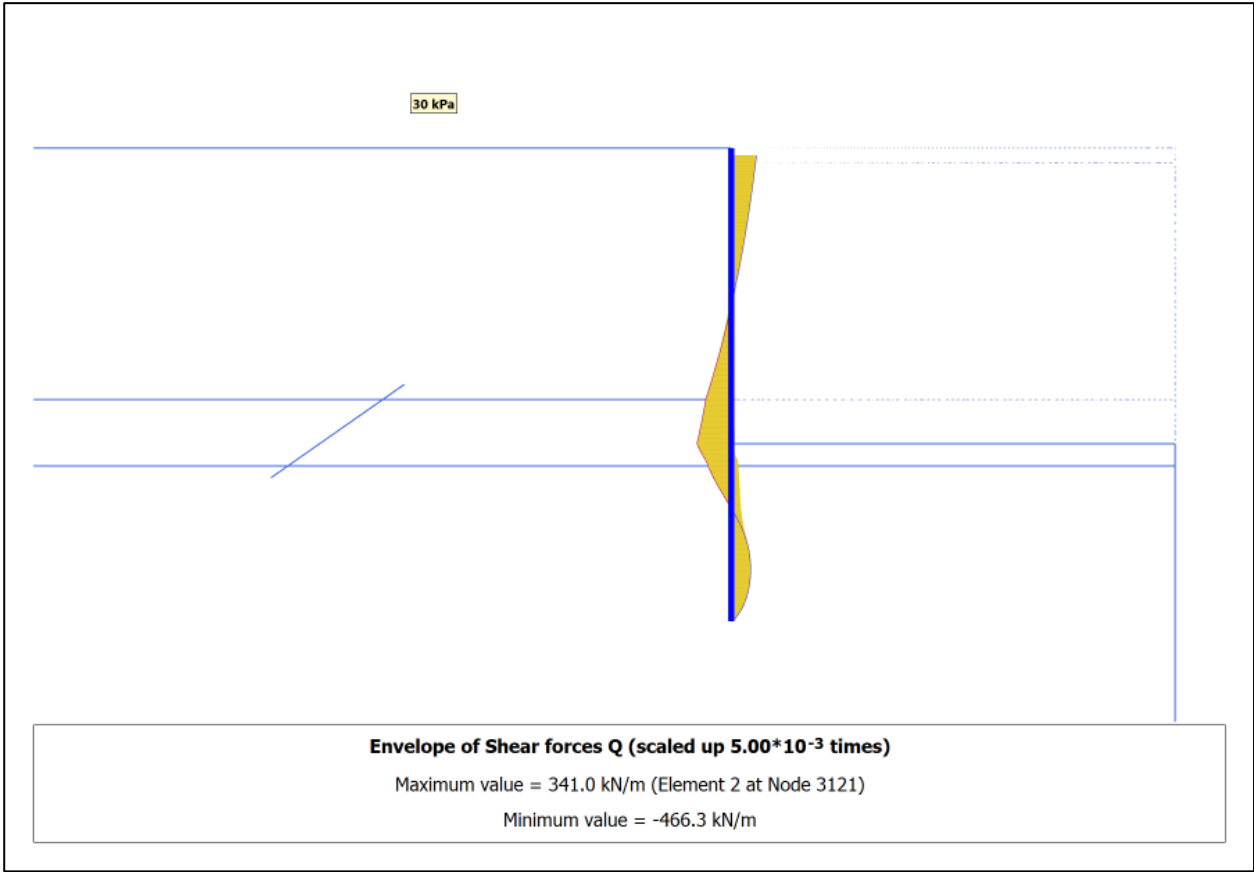


-  Coraline Limestone
-  Loose Sand
-  Medium Dense Sand



3.2.1 Internal Forces of Bored Pile

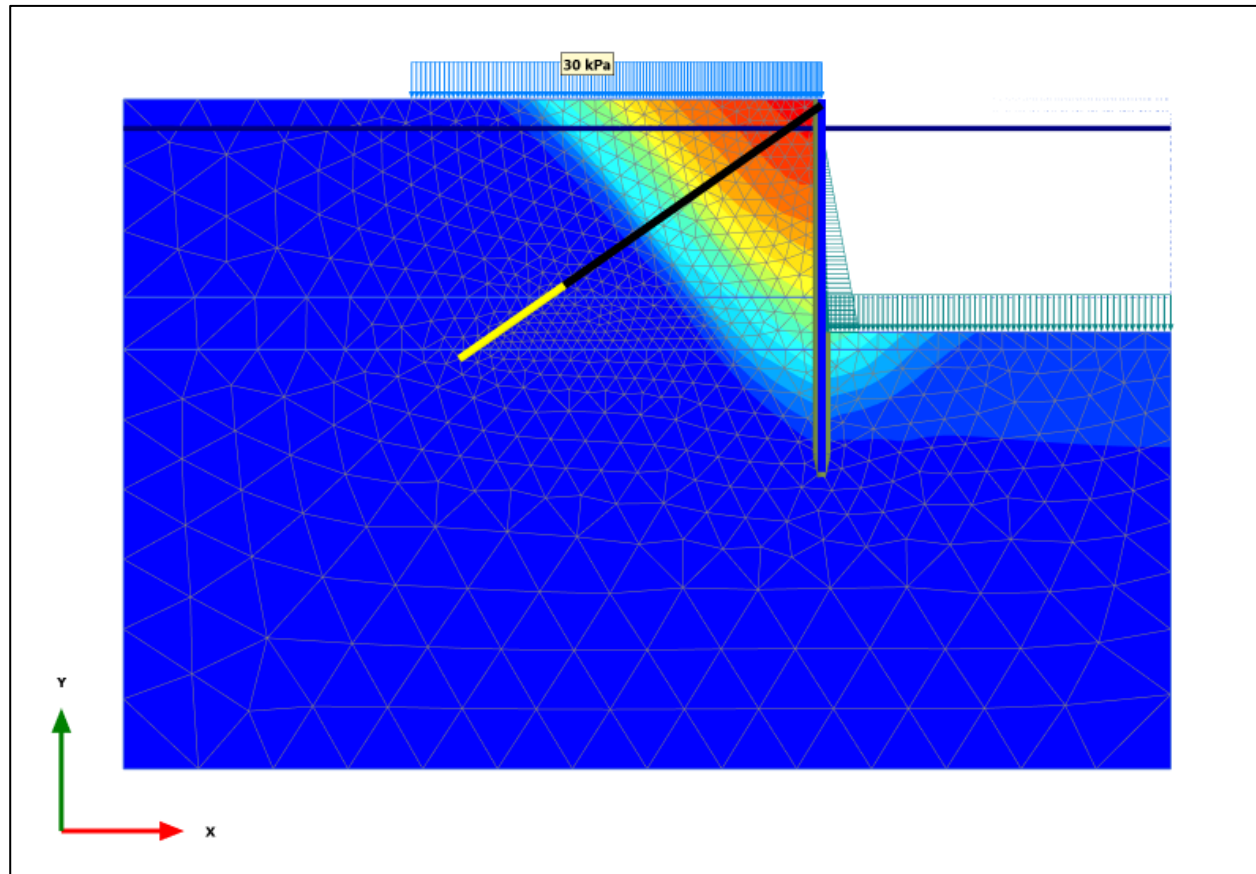




Anchor Forces

Structural element ▲	Node ▲	Local number ▲	X ▲ [m]	Y ▲ [m]	N ▲ [kN]	N _{min} ▲ [kN]	N _{max} ▲ [kN]
NodeToNodeAnchor_1_1	3121	1	0.000	2.000	1200.000	0.000	1200.000
Element 1-1 (Node-to-node anchor)	12996	2	-22.117	-13.487	1200.000	0.000	1200.000

3.2.2 Overall Stability Analysis

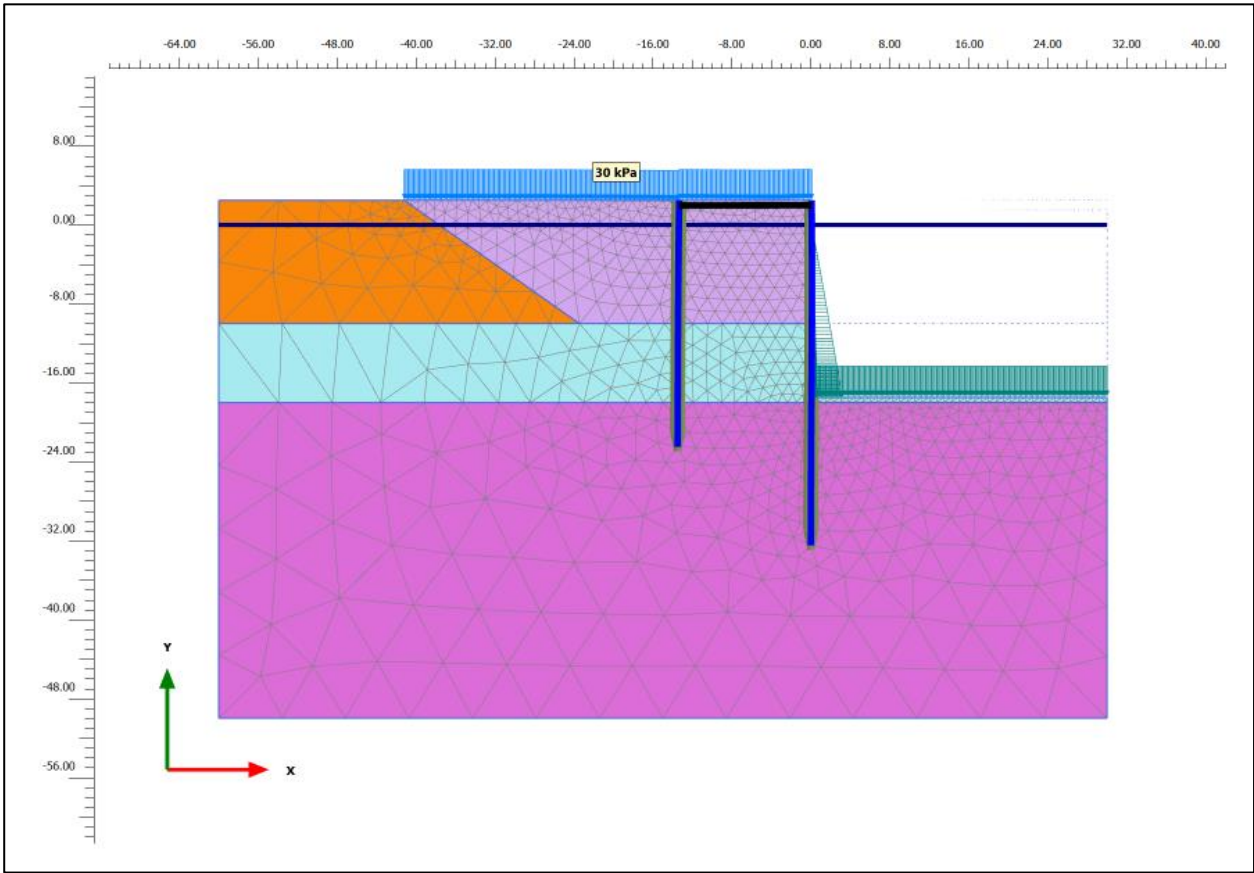


Multipliers

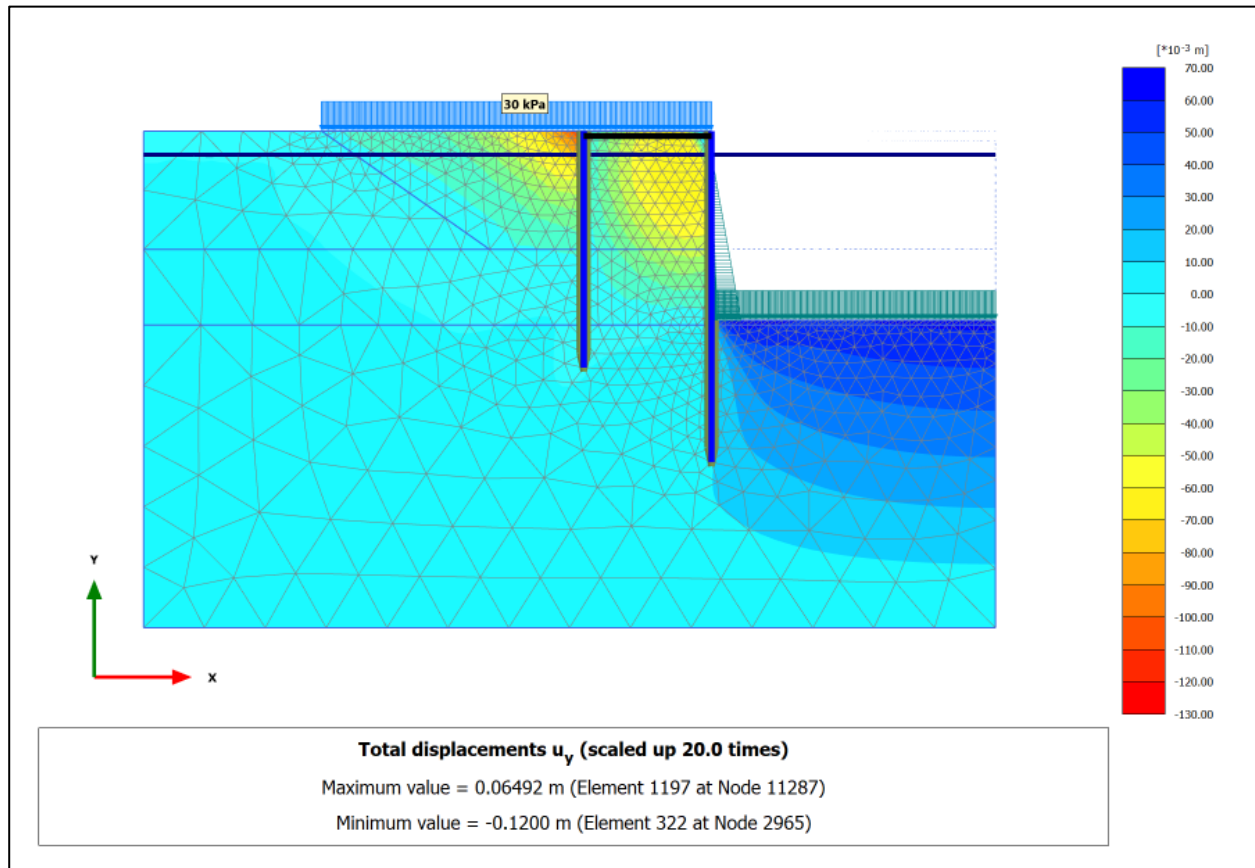
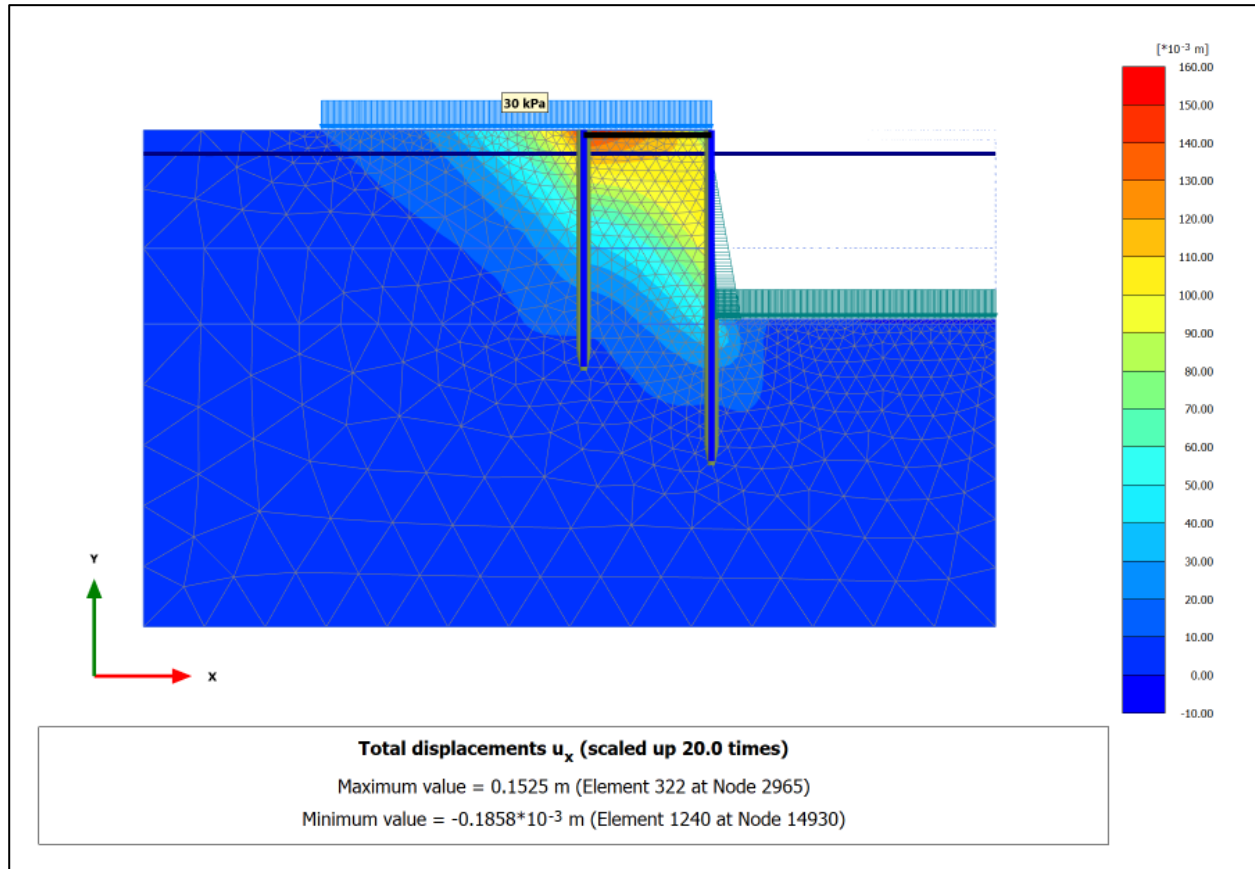
Soil weight			ΣM_{Weight}	1.000
Strength reduction factor	M_{sf}	-0.2820E-3	ΣM_{sf}	1.537
Time	Increment	0.000	End time	0.000

Overall Factor of Safety: $1.537 > 1.35$ OK

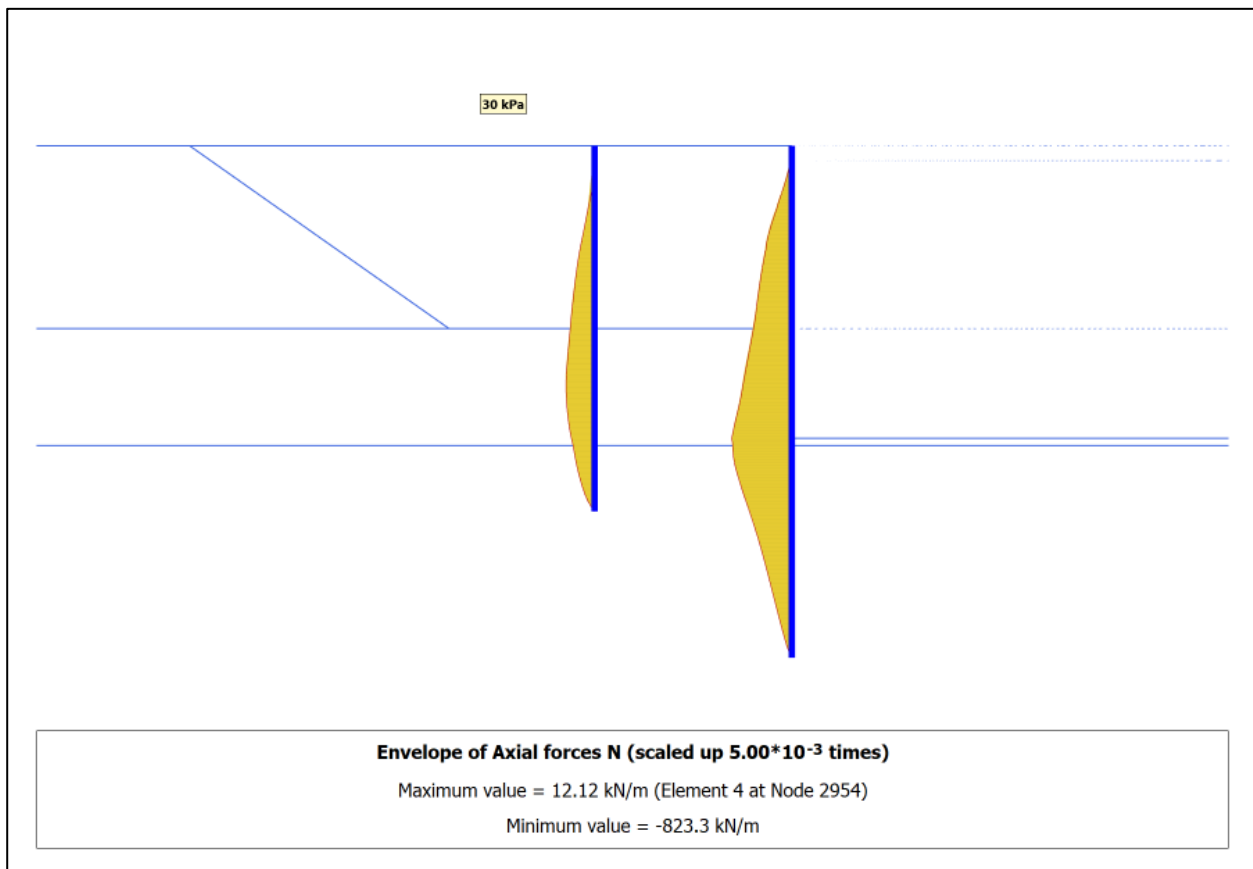
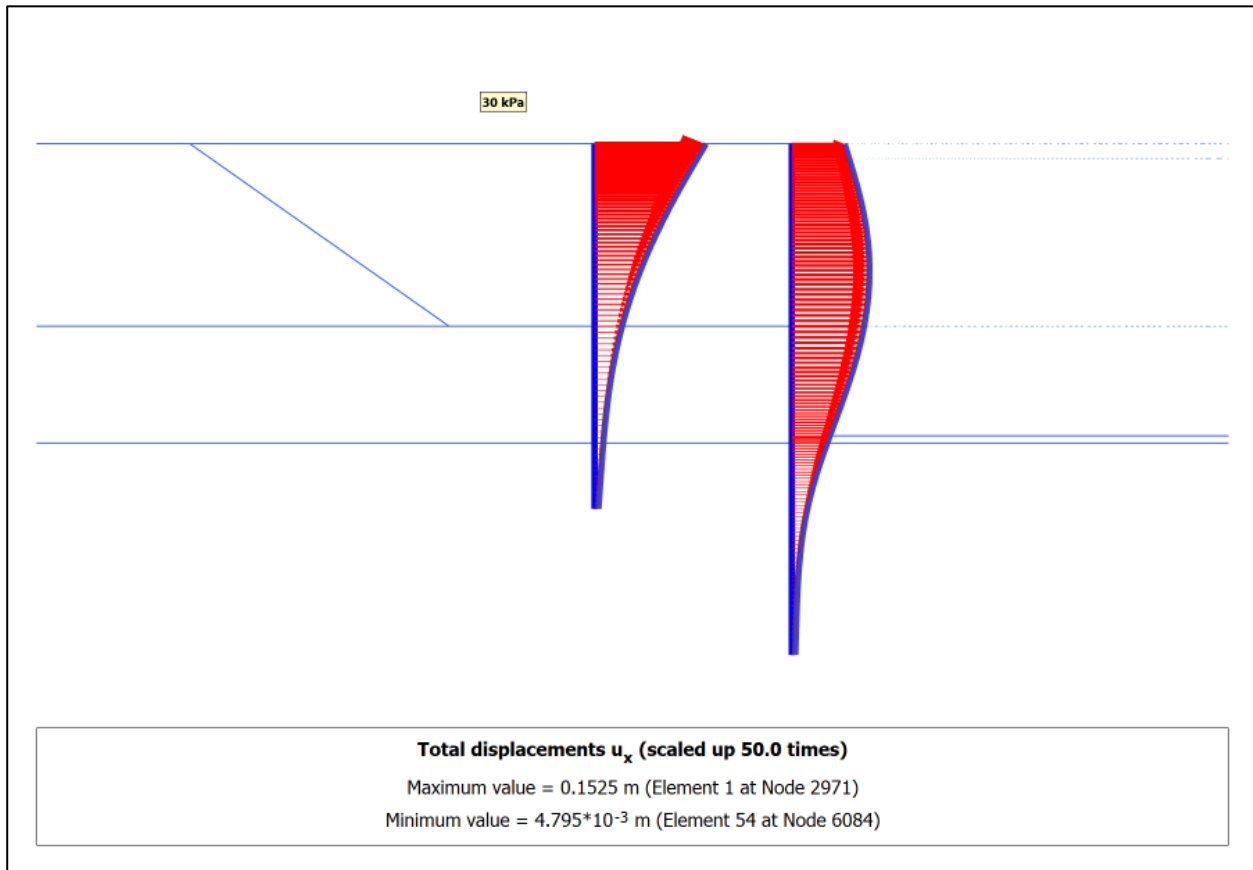
3.3 Section C

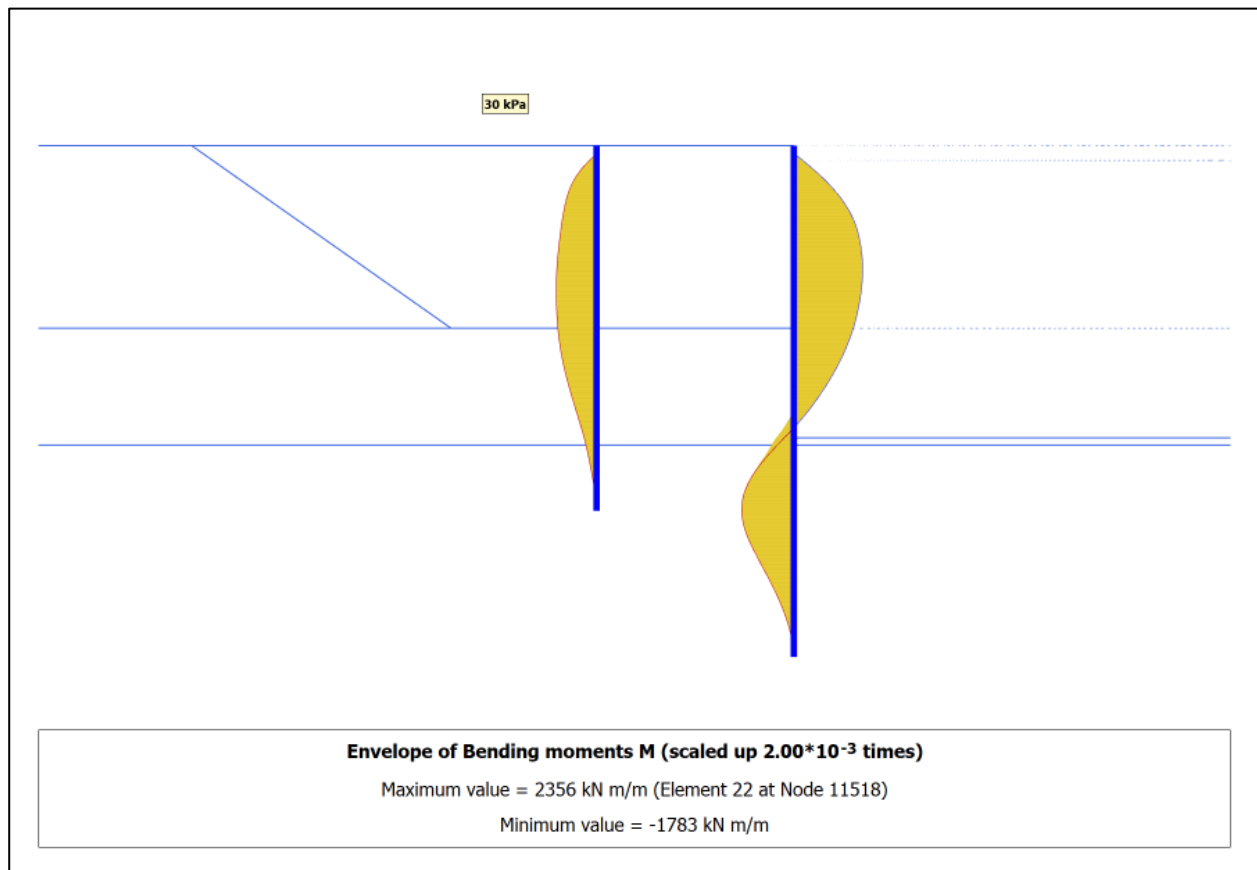
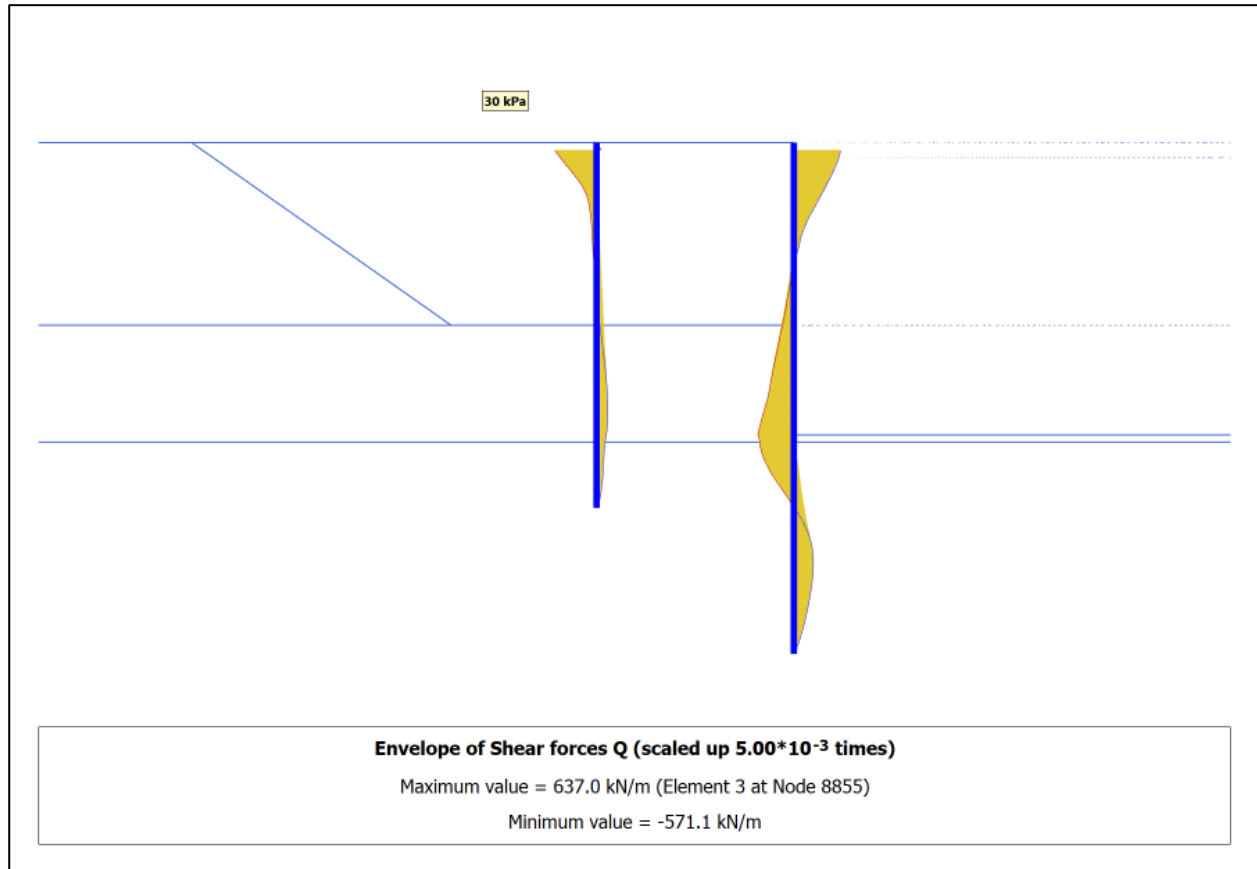


- CoralineLimestone
- LooseSand
- MediumDenseSand
- RockFill



3.3.1 Internal Forces of Bored Pile

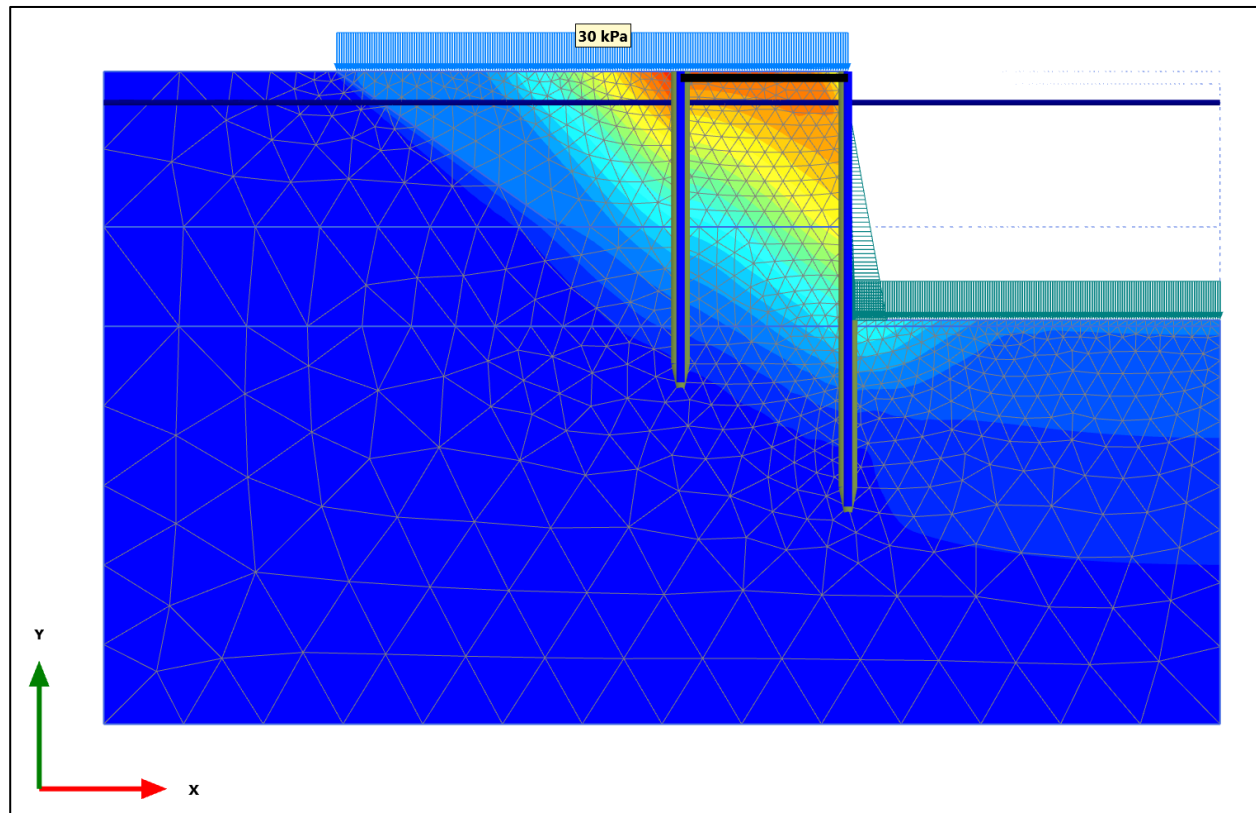




Anchor Forces

Structural element	Node	Local number	X [m]	Y [m]	N [kN]	N _{min} [kN]	N _{max} [kN]
NodeToNodeAnchor_1_1	8855	1	0.000	1.982	1918.107	0.000	1918.107
Element 1-1 (Node-to-node anchor)	2970	2	-13.500	1.982	1918.107	0.000	1918.107

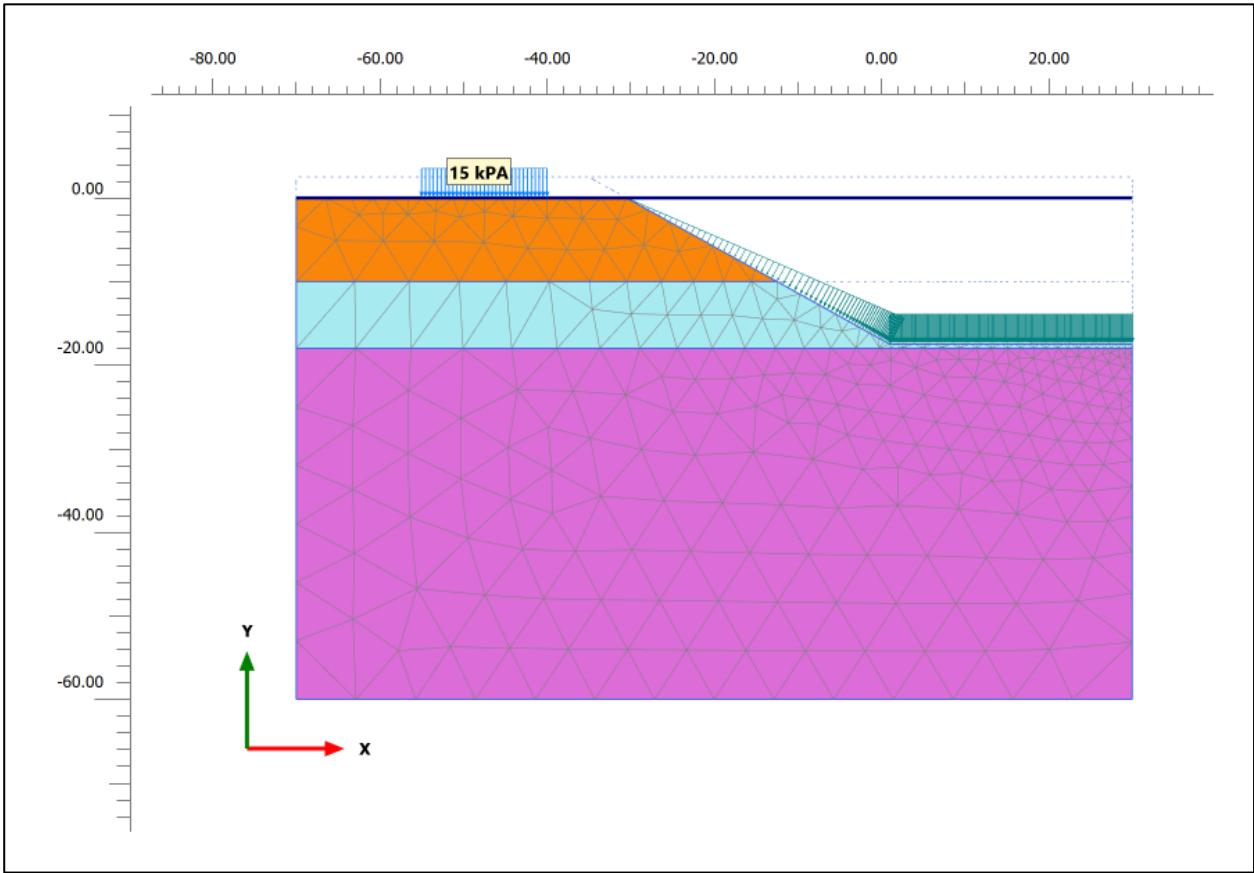
3.3.2 Overall Stability Analysis



Multipliers				
Soil weight			ΣM_{Weight}	1.000
Strength reduction factor	M_{sf}	-0.4677E-3	ΣM_{sf}	1.372
Time	Increment	0.000	End time	0.000

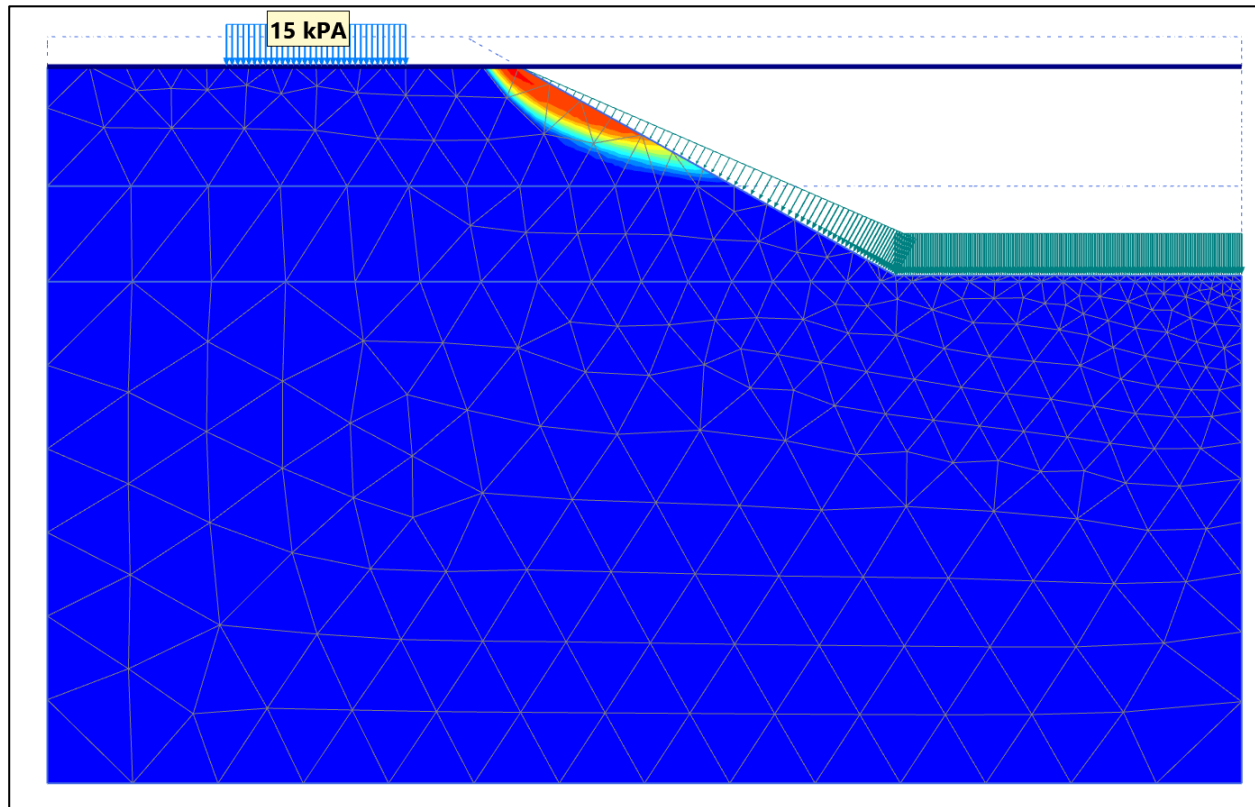
Overall Factor of Safety: $1.372 > 1.35$ OK

3.4 Section D



-  Coraline Limestone
-  Loose Sand
-  Medium Dense Sand

3.4.1 Overall Stability Analysis



Multipliers				
Soil weight			ΣM_{Weight}	1.000
Strength reduction factor	M_{sf}	0.6142E-3	ΣM_{sf}	1.388
Time	Increment	0.000	End time	0.000

Overall Factor of Safety: $1.39 > 1.35$ OK

3.5 Anchor Bond Length

3.5.1 Check of Number of Strands for Ground Anchors

Check of Number of Strands for Ground Anchors								
Region	Type	Design Load (kN)	Max. Test Load (kN)	Strand Type	Tendon Breaking Load (kN)	Required Number of Strand for Static Design Load (FS=2)	Required Number of Strand for Acceptance Test Load (0.8xftk)	Selected Number of Strand
All	SBMA	1200	1800	15.2 mm	260	9.23	8.65	10

3.5.2 Safety Check for Steel-Encapsulation and Duct-Grout Interface

Safety Check for Steel-Encapsulation and Duct-Grout Interface								
Designated category	Static load (kN)	Design Properties for Ground Anchors				Bond Stress for Steel/Encapsulation Grout Interface (MPa)	Bond Stress for Duct/Anchor Grout Interface (MPa)	Safety Check
		Unit Fixed Length (m)	Number Of Units	Number Of Strands	Lock-Off Loads for Each Units (kN)			
A	1200	3.50	1	4	480	0.716	0.582	✓
		3.50	1	3	360	0.716	0.437	✓
		3.50	1	3	360	0.716	0.437	✓

3.5.3 Safety Check for Ground-Grout Interface

Typical ranges of ultimate bond stress values for the rock/grout interface which have been measured are provided in Table 1. Alternatively, PTI (1996) suggests that the ultimate bond stress between rock and grout can be approximated as 10 percent of the unconfined compressive strength of the rock up to a maximum value for ultimate bond stress of 1.0 – 5.0 MPa.

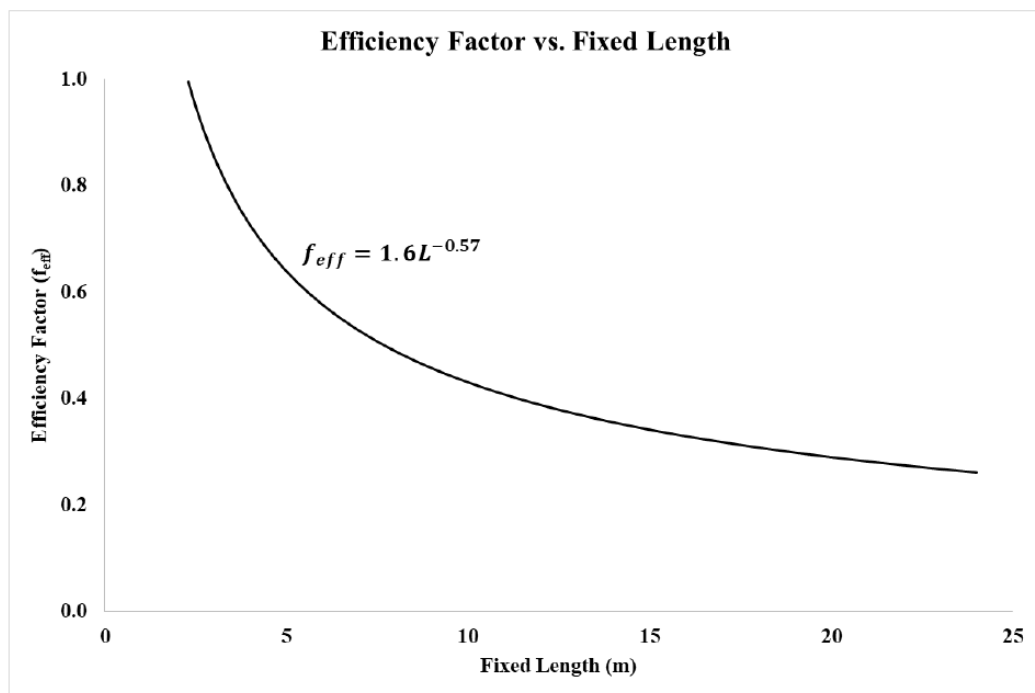
Based on the approach suggested in Table-1 (PTI, 1996), it is understood that this value is a little higher. Because obtained strength values are highly dependent on the specimen size. Pictures of specimens can be seen in the soil report. To stay on the safe side in the calculation, the values in Table-2 have been used.

Table 1. Presumptive ultimate values of load transfer for preliminary design of ground anchors in rock (FHWA-IF-99-015)

Rock type	Estimated ultimate transfer load (kN/m)
Granite or Basalt	730
Dolomitic Limestone	580
Soft Limestone	440
Sandstone	440
Slates and Hard Shales	360
Soft Shales	150

Selected Load Per Meter = 440 kN/m

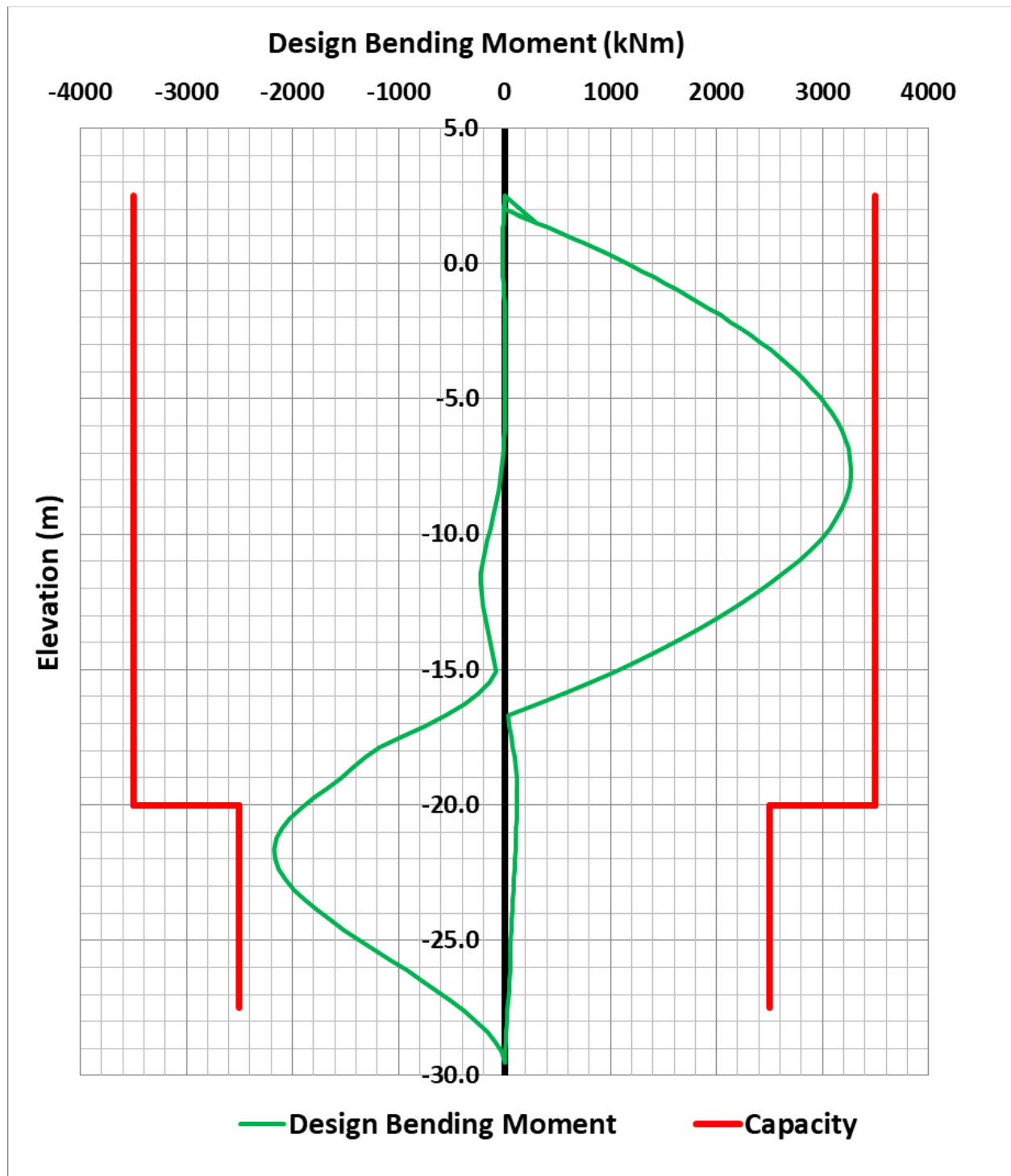
Safety Check for Ground-Grout Interface											
Designated category	Static load (kN)	Seismic Load (kN)	Average Ultimate Bond Stress (kPa)	Unit Fixed Length (m)	Number Of Units	Drilling Diameter (m)	Efficiency Factor (f_{eff})	Enhancement Factor	Ultimate Load Capacity of Each Units (t_{ult}) (kN)	Total Ultimate Load Capacity of Anchor (kN)	Safety Check for Ground-Grout Interface
											For Lock-Off Load (FS>3)
A	1200	0	651	3.50	1	0.215	0.783	1.00	1206	3617	✓
				3.50	1	0.215	0.783	1.00	1206		
				3.50	1	0.215	0.783	1.00	1206		



4. Structural Calculations

4.1 Bored Pile

4.1.1 Bending Capacity Graph for Section A-A



4.1.1.1 Section A-A (Upper Part)

MATERIALS:

$f_{cu} = 35.00$ N/mm²
 $f_y = 500.00$ N/mm²

$\gamma_m = 1.15$ steel
 $\gamma_m = 1.50$ concrete

Cover = 50.00 mm
 $h_{agg} = 20.00$ mm

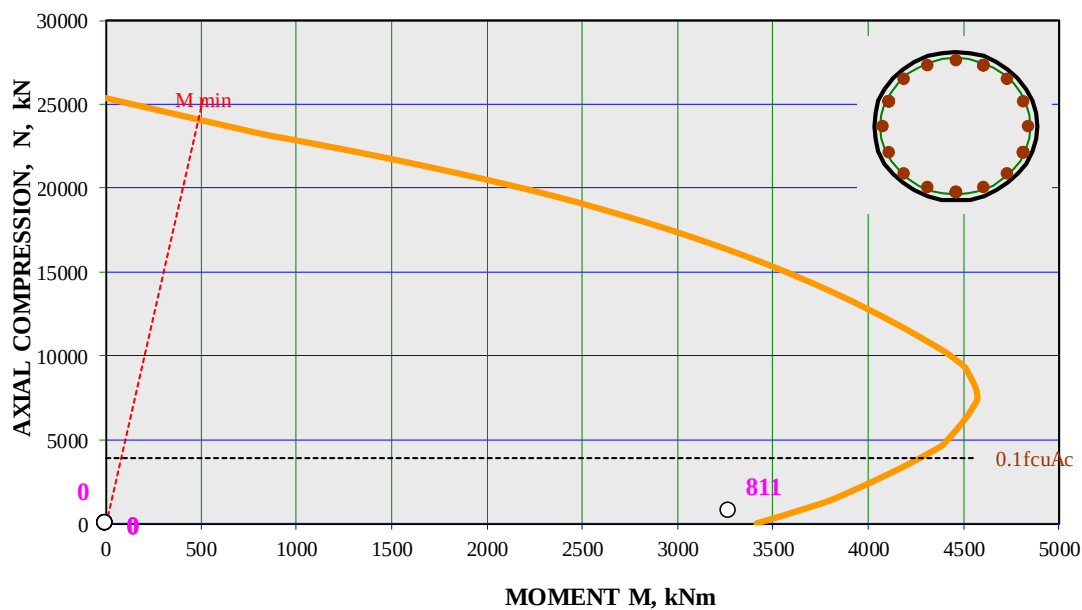
SECTION:

$h = 1200.00$ mm with 16 bars

BAR ARRANGEMENTS:

Type	Bar Ø	Asc %	Link Ø	Bar c/c	Nbal (kN)	Nuz (kN)	Checks
R	38	1.62	12	203.77	7366.10	25366.97	ok

N:M INTERACTION CHART for 1200 diameter column, grade C35, 50 mm cover and 16 bars



LOADCASES:

Load case	Nd=N	Md = 1.35xM	
Case-1	810.60	3267.81	O.K

Load case	N (kN)	M (kNm)	

Selected Reinforcement: 12 Φ 40 + 4 Φ 32 (to satisfy the 1.62% reinforcement ratio.)

4.1.1.2 Section A-A (Lower Part)

MATERIALS:

$f_{cu} = 35.00$ N/mm²
 $f_y = 500.00$ N/mm²

$\gamma_m = 1.15$ steel
 $\gamma_m = 1.50$ concrete

Cover = 50.00 mm
 $h_{agg} = 20.00$ mm

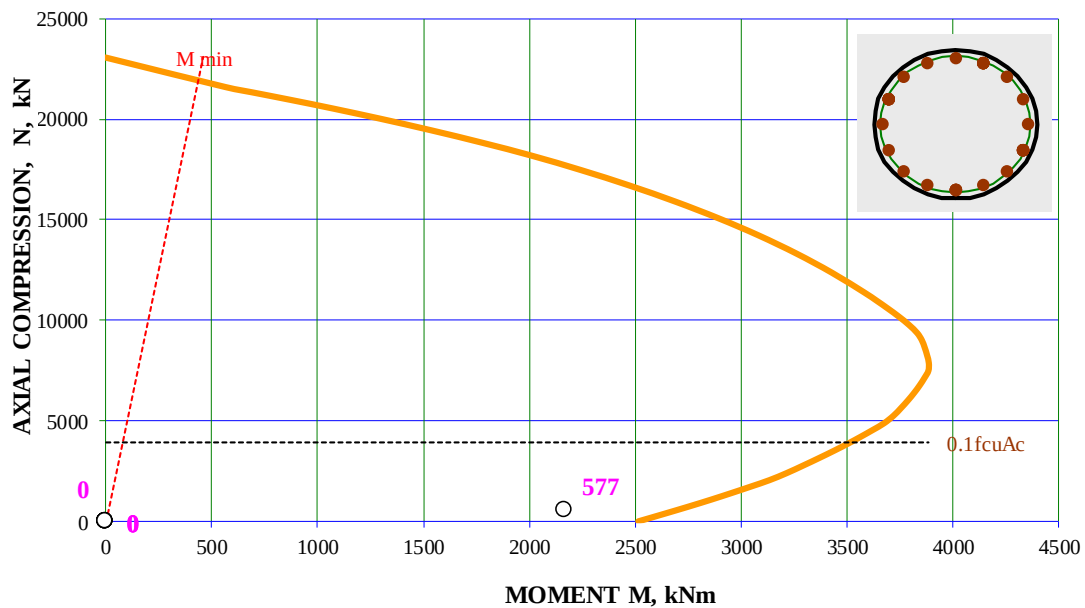
SECTION:

$h = 1200.00$ mm with 16 bars

BAR ARRANGEMENTS:

Type	Bar Ø	Asc %	Link Ø	Bar c/c	Nbal (kN)	Nuz (kN)	Checks
R	32	1.14	12	204.99	7881.56	23074.48	ok

N:M INTERACTION CHART for 1200 diameter column, grade C35, 50 mm cover and 16 bars



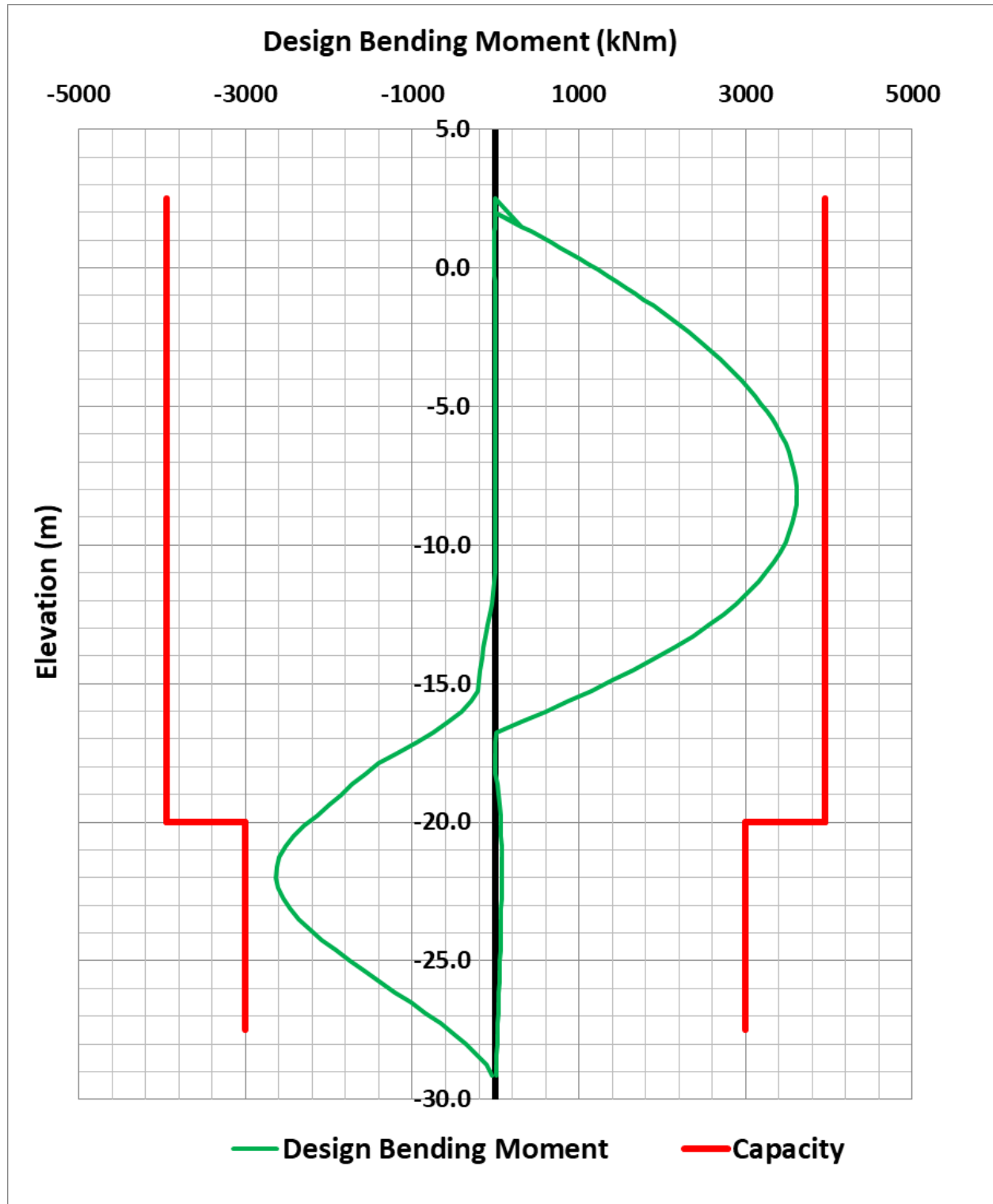
LOADCASES:

Load case	Nd=N	Md = 1.35xM	
Case-1	576.80	2169.33	O.K

Load case	N (kN)	M (kNm)	

Selected Reinforcement: 16 Φ 32

4.1.2 Bending Capacity Graph for Section B-B



4.1.2.1 Section B-B (Upper Part)

MATERIALS:

$f_{cu} = 35.00$ N/mm²
 $f_y = 500.00$ N/mm²

$\gamma_m = 1.15$ steel
 $\gamma_m = 1.50$ concrete

Cover = 50.00 mm
 $h_{agg} = 20.00$ mm

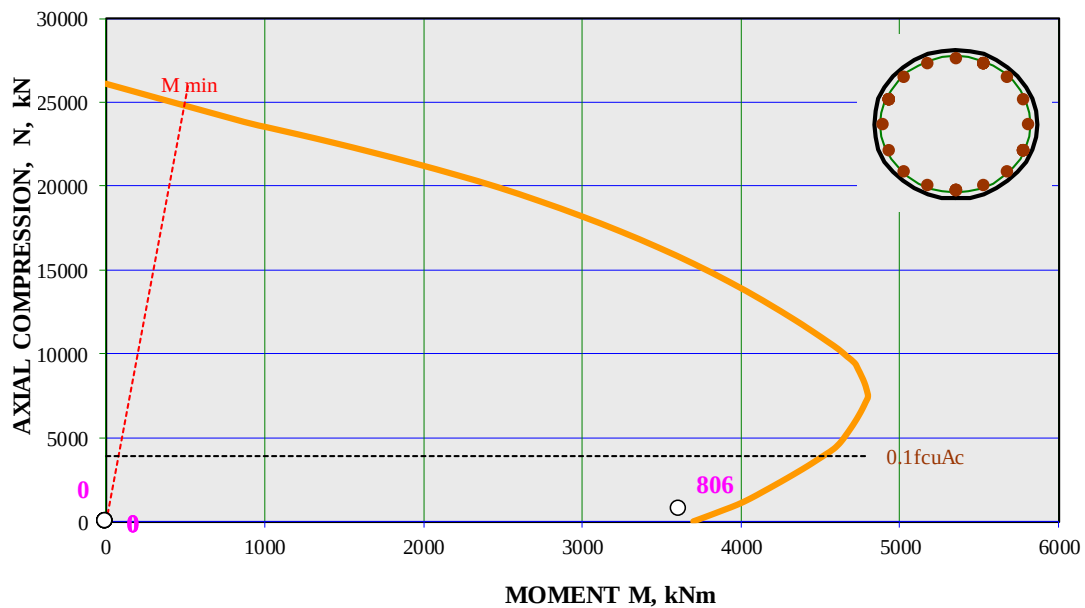
SECTION:

$h = 1200.00$ mm with 16 bars

BAR ARRANGEMENTS:

Type	Bar Ø	Asc %	Link Ø	Bar c/c	Nbal (kN)	Nuz (kN)	Checks
R	40	1.78	12	203.42	7443.83	26108.38	ok

N:M INTERACTION CHART for 1200 diameter column, grade C35, 50 mm cover and 16 bars



KEY

16R40

LOADCASES:

Load case	Nd=N	Md = 1.35xM	
Case-1	805.70	3611.79	O.K

Load case	N (kN)	M (kNm)	

Selected Reinforcement: 16 Φ 40

4.1.2.2 Section B-B (Lower Part)

MATERIALS:

$f_{cu} = 35.00$ N/mm²
 $f_y = 500.00$ N/mm²

$\gamma_m = 1.15$ steel
 $\gamma_m = 1.50$ concrete

Cover = 50.00 mm
 $h_{agg} = 20.00$ mm

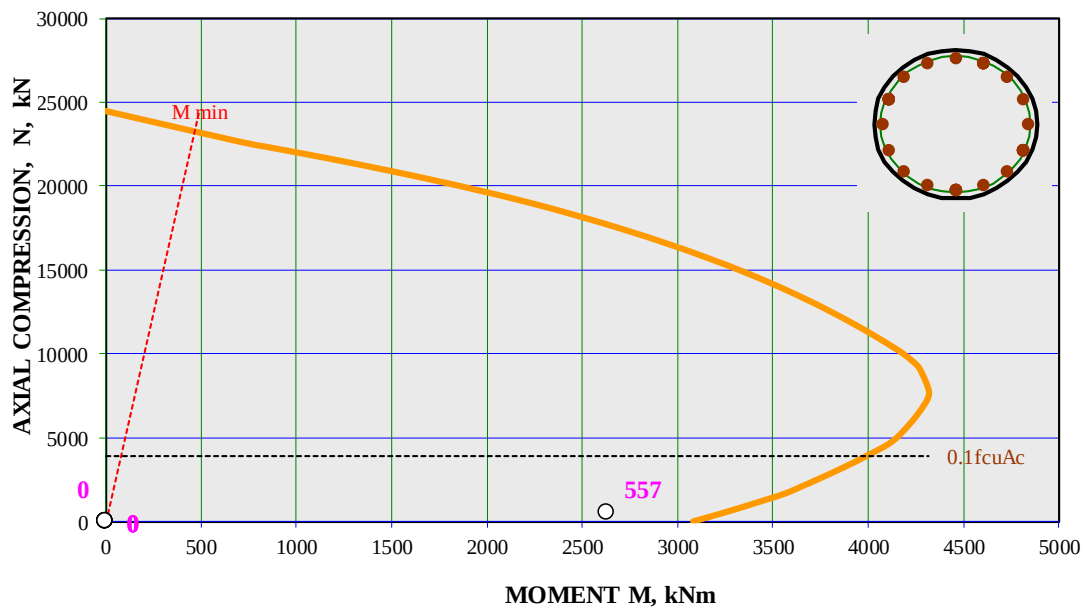
SECTION:

$h = 1200.00$ mm with 16 bars

BAR ARRANGEMENTS:

Type	Bar Ø	Asc %	Link Ø	Bar c/c	Nbal (kN)	Nuz (kN)	Checks
R	36	1.44	12	204.20	7659.14	24507.16	ok

N:M INTERACTION CHART for 1200 diameter column, grade C35, 50 mm cover and 16 bars



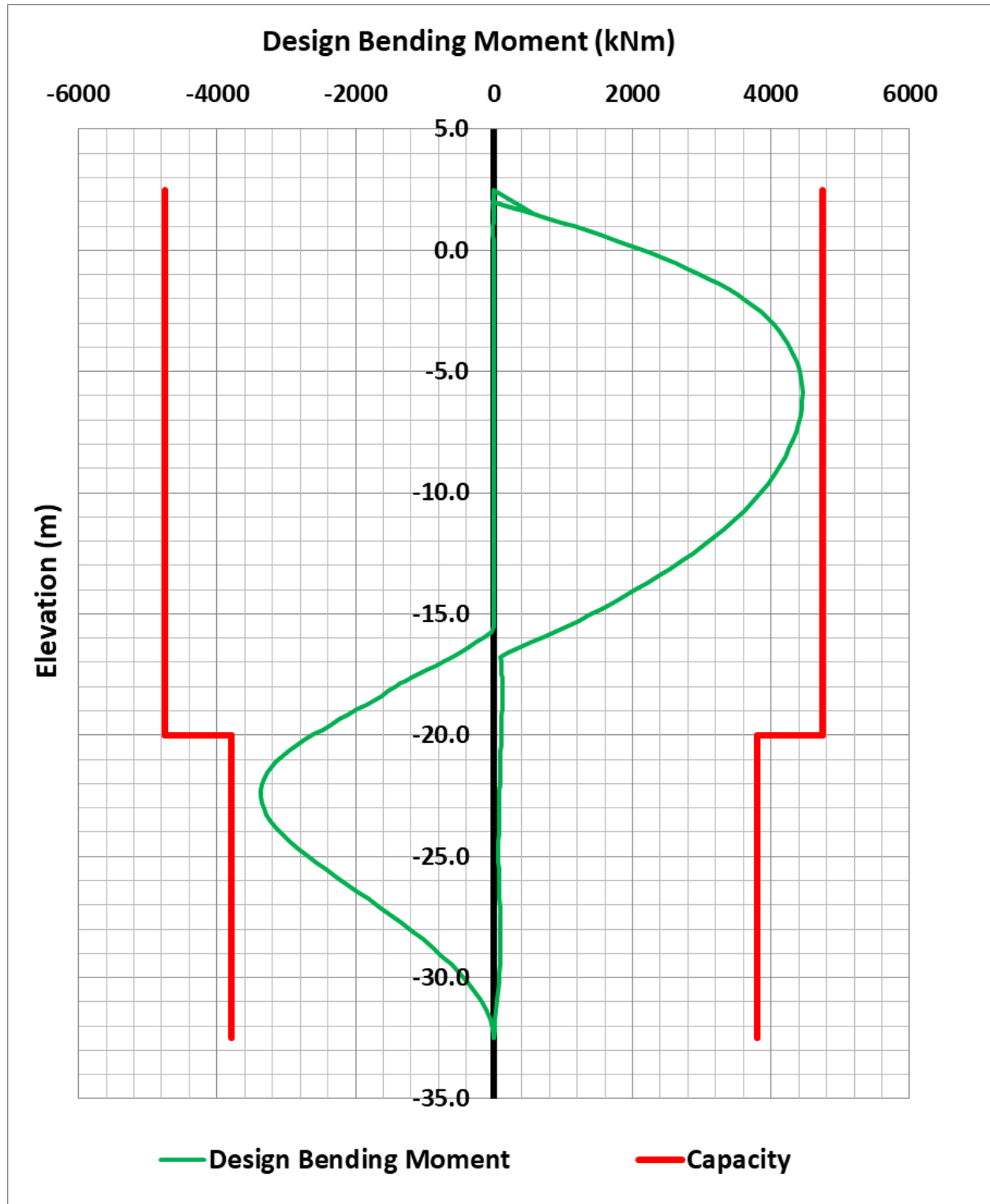
LOADCASES:

Load case	Nd=N	Md = 1.35xM	
Case-1	556.50	2631.90	O.K

Load case	N (kN)	M (kNm)	

Selected Reinforcement: 8 Φ 40 + 8 Φ 32 (to satisfy the 1.44% reinforcement ratio.)

4.1.3 Bending Capacity Graph for Section C-C (Front Pile)



4.1.3.1 Section C-C (Upper Part)

MATERIALS:

$f_{cu} = 35.00$ N/mm²
 $f_y = 500.00$ N/mm²

$\gamma_m = 1.15$ steel
 $\gamma_m = 1.50$ concrete

Cover = 50.00 mm
 $h_{agg} = 20.00$ mm

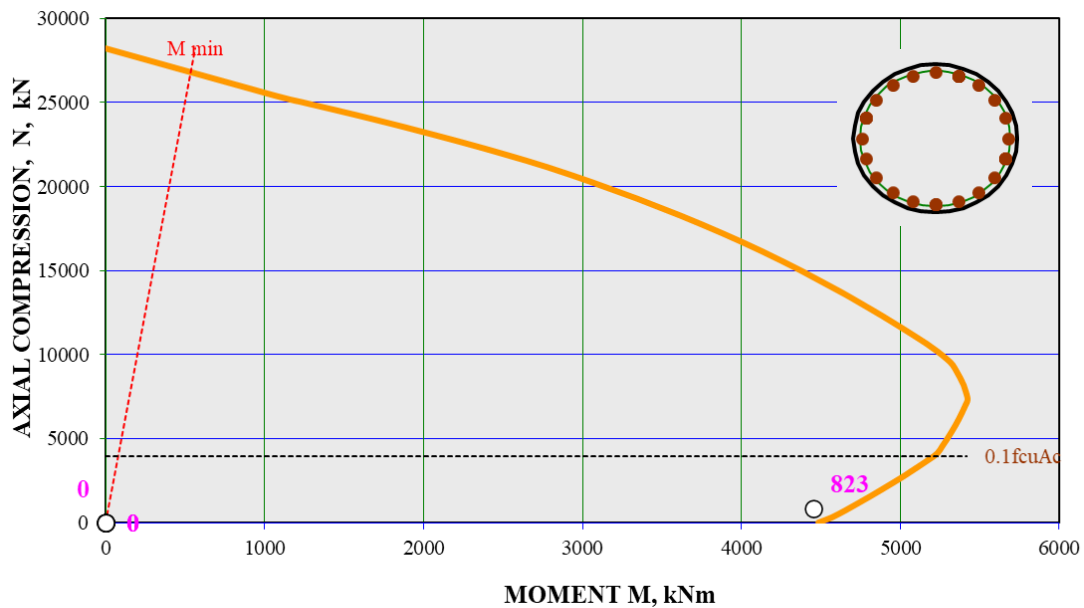
SECTION:

$h = 1200.00$ mm with 20 bars

BAR ARRANGEMENTS:

Type	Bar Ø	Asc %	Link Ø	Bar c/c	Nbal (kN)	Nuz (kN)	Checks
R	40	2.22	12	162.73	10008.83	28215.25	ok

N:M INTERACTION CHART for 1200 diameter column, grade C35, 50 mm cover and 20 bars



KEY

20R40

LOADCASES:

Load case	Nd=N	Md = 1.35xM	
Case-1	823.20	4453.30	O.K

Load case	N (kN)	M (kNm)	

Selected Reinforcement: 20 Φ 40

4.1.3.2 Section C-C (Lower Part)

MATERIALS:

$f_{cu} = 35.00$ N/mm²
 $f_y = 500.00$ N/mm²

$\gamma_m = 1.15$ steel
 $\gamma_m = 1.50$ concrete

Cover = 50.00 mm
 $h_{agg} = 20.00$ mm

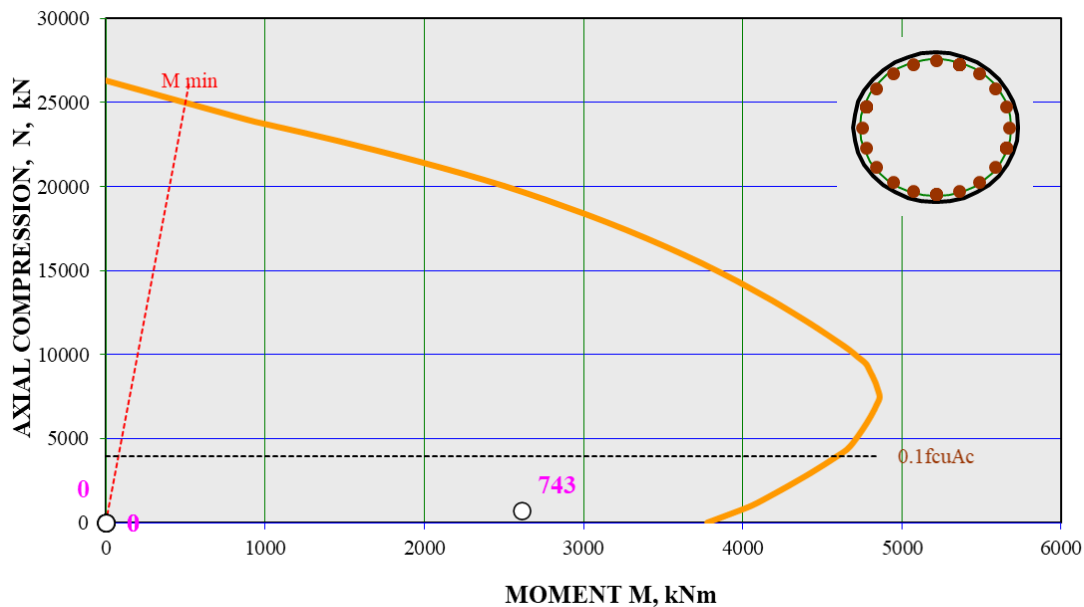
SECTION:

$h = 1200.00$ mm with 20 bars

BAR ARRANGEMENTS:

Type	Bar Ø	Asc %	Link Ø	Bar c/c	Nbal (kN)	Nuz (kN)	Checks
R	36	1.82	12	163.33	9986.32	26308.80	ok

N:M INTERACTION CHART for 1200 diameter column, grade C35, 50 mm cover and 20 bars



KEY

20R36

LOADCASES:

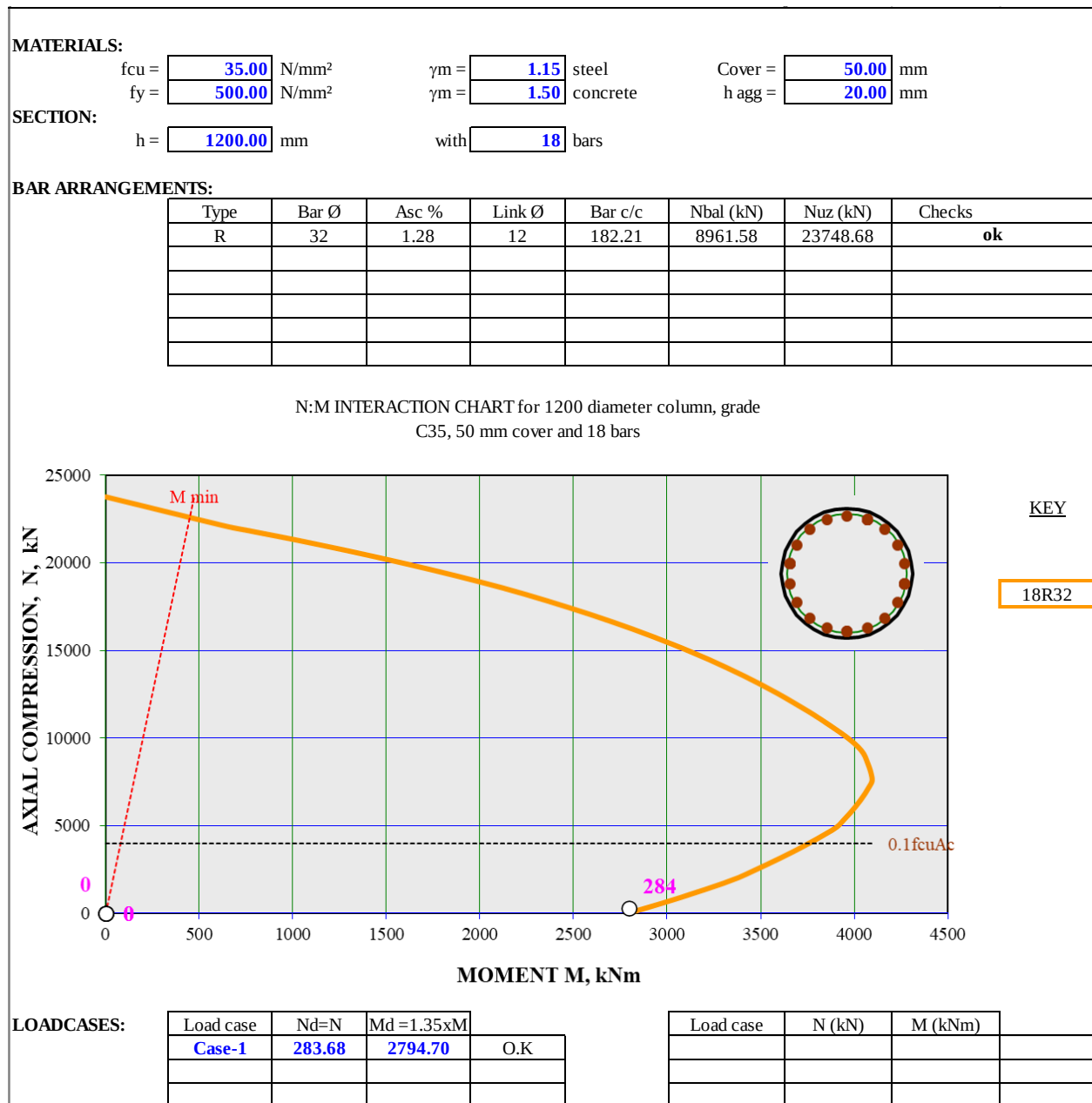
Load case	Nd=N	Md=1.35xM	
Case-1	743.14	2608.59	O.K

Load case	N (kN)	M (kNm)	

Selected Reinforcement: 10 Φ 40 + 10 Φ 32 (to satisfy the 1.82% reinforcement ratio.)

4.1.4 Bending Capacity Graph for Section C-C (Back Pile)

4.1.4.1 Section C-C (Back Pile)



Selected Reinforcement: 18 Φ 32

4.1.5 Stirrup

STIRRUP DESIGN (IN ACCORDANCE to ACI 318M)									
Reduction Factor ϕ :	0.75								
Modification Factor λ :	1.0								
Pile Diameter (m) :	1.2								
Cover (mm) :	100.0								
Steel Yield Strength (MPa) :	420.0								
Section	Concrete Class	f_c (N/mm ²)	V_c (kN)	Stirrup Dia. (mm)	s (mm)	V_s (kN)	V_n (kN)	V_d (kN)	Status
A	C35	35	1137.46	Ø12	150	696.68	1375.60	757.9	O.K
B	C35	35	1137.46	Ø12	150	696.68	1375.60	881.3	O.K
C	C35	35	1137.46	Ø12	150	696.68	1375.60	1203.9	O.K

Selected Stirrup: Φ12 /150

4.2 Head Beam

The anchor force for head beam: 1200 kN

Spacing: 3.00 m

$M_{max} = q \times L^2 / 11 = 327.3 \text{ kN.m}$ (where $q=1200/3.00 = 400.0 \text{ kN/m}$)

$V_{max}=q \times L / 2 = 600.0 \text{ kN}$

$M_{design} = 1.35 \times 327.3 = 441.9 \text{ kN.m}$

$V_{design} = 1.35 \times 600.0 = 810.0 \text{ kN}$

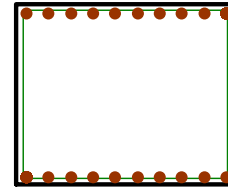
CALCULATION REPORT of SHORING SYSTEM

MATERIALS

f_{cu}	35 N/mm ²	γ_s	1.15
f_y	500 N/mm ²	γ_c	1.50

SECTION

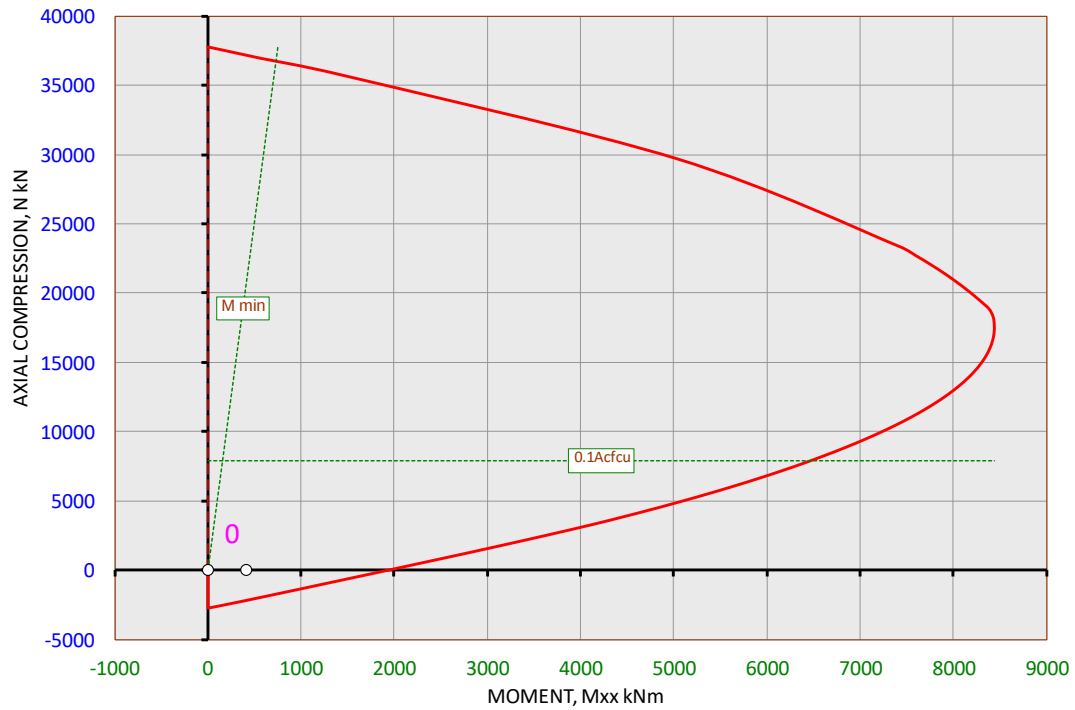
h	1500 mm	COVERS (to main steel)	
b	1500 mm	TOP	50 mm
		BOTTOM	50 mm
		SIDES	50 mm



REINFORCEMENT

	Bar Ø	No	Area	%	Space
TOPRAK TARAFI	20	10	3142	0.140	133.3
KAZI TARAFI	20	10	3142	0.140	133.3

M:N interaction chart for 1,500 x 1,500 section, C35 concrete.



LOADCASES

KESİT	Nd N (kN)	Md (kNm)			
I	0	411.9			

STIRRUP DESIGN (IN ACCORDANCE to ACI 318M)

Reduction Factor ϕ :	0.75
Modification Factor λ :	1.0
Wale Beam Width (m) :	1.5
Wale Beam Height (m) :	1.5
Cover (mm) :	50.0
Steel Yield Strength (MPa)	420.0

Section	Concrete Class	f_c (N/mm ²)	V_c (kN)	Stirrup Dia. (mm)	# of Hook	s (mm)	V_s (kN)	V_n (kN)	V_d (kN)	Status
All	C35	35	2262.90	Ø12	4	150	1836.70	3074.70	810.0	O.K

Selected Reinforcement: 2x10Φ20

Selected Stirrup: 2xΦ12 /150

5. Trigger Levels and Measurement Frequency

Trigger Levels and measurement frequencies and the levels that change the measurement frequency are shown in below Table 6-1 and 6-2 respectively.

Table 4. Alert/Action/Alarm Trigger Levels at Final Excavation Level

Section	Calculated Deformation (mm)	Alert Level (mm)	Action Level (mm)	Alarm Level (mm)
A-A	68.64	85.80	107.25	134.06
B-B	84.73	105.91	132.39	165.48
C-C	152.50	190.62	238.28	297.85

Table 5. Frequencies of Displacement Measurement

DESCRIPTION	Normal Frequency	Alert Frequency	Action Frequency	Alarm Frequency
During excavation works	2/week	1/day	2/day	2/day
After completing the excavation	2/week	1/day	2/day	2/day

6. References

- EN 1993 Design of Steel
- EN 1997 Geotechnical Design
- FHWA-IF-99-015
- BS 8081:2015
- ACI-318M
- Geotechnical Engineering Circular No.4 Ground Anchors and anchored systems, U.S Department of Transportation, June 1999
- Das, B.M., (2007). Principles of Geotechnical Engineering. Canada.
- Budhu, M. (2015). Soil Mechanics Fundamentals. West Sussex, United Kingdom: John Wiley & Sons Ltd.
- Bowles, L. E. (1996). Foundation analysis and design. McGraw-hill.
- CGS18009- Geotechnical Soil Investigation for Development of the Port Platform (From 26 To 31) Project Jeddah Islamic Seaport (JIP), Jeddah - KSA Prepared by Bakri, dated June 2018.
- ACTS-KSA-Q20017-22-Final Geotechnical Investigation Report for Development of the Port Platform (From 26 To 31) Project Jeddah Islamic Seaport (JIP), Jeddah - KSA Prepared by ACTS, dated April 2022.